REFINER
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Editor

CONTENTS

Special Features

Combined Vapor Recovery and Stabilization System.....157
J. C. Albright

Operating Practice at Coltexo Gasoline Plant.....161

Refinery Engineering Developments.....166
H. R. Swanson and M. B. Cooke

Sludge.....172
L. C. Trescott

Methods of Determining Sulfur in Petroleum Products.....177
Russell M. Lilly

Lubricating Greases.....180
C. C. Wilch

Elements of Stabilization.....184
I. N. Beall

Regular Grade Cracked Gasoline and "Q" Grade Ethyl Compared.....189
William Hubner and George B. Murphy

Viscosity Change Comparison Chart.....192
Richard Grosholz

Regular Departments

Science and Technology.....42a

The Month in Review.....57a

Plant Activities.....69a

New Equipment for the Modern Plant.....71a

Items About Manufacturers.....77a

Catalogs and Bulletins.....79a

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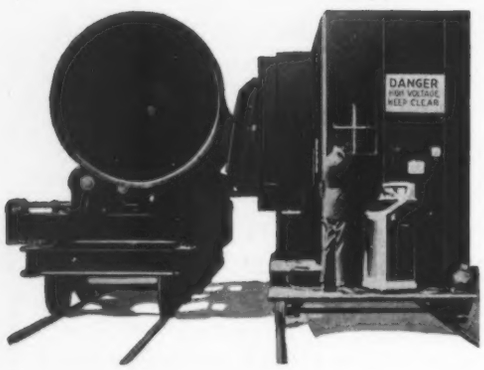

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Refinery Control

The new refinery control plan adopted in lieu of Article IV of the oil code, whether a step in the right direction or not, is something concrete and definite with which refiners may concern themselves that has come out of the conferences, hearings, proposals and plans at Washington. Under the refinery control plan, which is said to be a modification of the proposal submitted by Axtell J. Byles on behalf of 24 of the leading oil companies during the Petroleum Administrative Board hearings, supervision over the plan is invested in the Planning and Coordination Committee, subject to appeal to and approval by the administrator.

The scheme is a complete modification of Article IV of the original oil code. It provides for a national coordinator of refining operations, allocators of production, boards of review and other agencies, set up by the Planning and Coordination Committee.

The adoption of the refinery control plan removes this matter from Secretary Ickes' oil control bill which he has been planning to ask congress to pass. The bill has also been shorn of its marketing provisions, and has gotten back to its original scope of bolstering and making more permanent the control of crude oil production.

While the new refinery control plan has been hailed in some quarters as the key to profits in the industry, it has also elicited growls of distrust, or silences of misgivings in other quarters, with elements among both independents and majors entertaining apprehensions. All agree that some advantages are offered, but express the thought that it may not be worth the price of further surrender to governmental restraint and regulation.

Since the refinery control plan is now a part of the oil code, it will remain in effect until expiration of the NIRA a year hence, and the oil administration hopes that within that time excessive gasoline stocks can be wiped out, leaving the refining oil situation favorable. If the oil bill passes congress, meanwhile, it would serve as a substitute for the production section of the code; but the newly adopted refinery section would continue operative for the year, and with gasoline stocks brought down in the meantime, the stage would be set for continued stabilization of the industry after NIRA, with crude control under the permanent law achieving the desired results. The revised refinery section of the code is published in full in this issue.

Rectifying Systems

A new series of articles dealing with high pressure rectifying columns begins in this issue. I. N. Beall, who has contributed a number of articles over the past two years dealing with various problems of natural gasoline manufacture, vapor recovery and stabilization systems, under the title "Elements of Stabilization" will discuss this important subject from the operator's viewpoint. He states "The first step in securing a conception of fractionation is to become familiar with the physical properties and characteristics of the components common to natural gasoline or natural gas condensate. With this in view Beall has prepared tables of the physical properties of the natural gas hydrocarbons expressed in English units—and these tables may be used as the basis for making charts and curves for handy reference.

Page 184.

Labor and the Code

Charges were brought at Washington during the month that operation under the code has not increased employment nor increased remuneration of workers in the oil industry. Other ideas are that the only result of the code has been to increase labor costs without adding revenue to cover the increases in wages. Other sectors report that the entire scheme of recovery as directed from Washington has failed. Somewhere in this conglomeration of ideas occurs a serious conflict.

Good service would be rendered oil and other industries, and the public at large, if some disinterested agency could compile comprehensive data on employment and wages. Department of Labor statistics on the number of people who have been put

back to work during the last six months apparently make no impression on some people. Mounting consumption of gasoline and other products, as reviewed from time to time through official figures of the Department of Commerce, should be of some benefit as an indication that the opportunity for employment in the oil industry has been broadened. The fact that the industry's operations are continuous and that men employed in the several branches have their appointed extra days off periodically should indicate that more men are employed.

But in the absence of an adding machine list on personnel and payroll figures all this is speculation. It leaves opportunity for recurring criticisms which echo unfavorably in quarters where there is not realization that the critics generally are of the "anti" element.

And speaking of the "anti" element, this industry seems to have more than its share, in that in addition to those, who for political or associated reasons, are hopeful that the scheme of recovery will fail, we have division of the "independent" and (so dubbed by the former) "monopolists," with a radical element of "independents" who would much prefer that the whole scheme of things should go to ruin than that the "monopolists" should prosper. With them are grouped the chronic offenders against orderly operation and price schedules and, as lieutenants, certain propagandists and others who occupy the outer fringe. Just at this time when the industry is in a lifeboat en route from the sinking ship toward what appears to be solid ground, it would appear a matter of discretion that the fight might wait, and the boat not be rocked by the combatants. Certain stalwarts in the ranks of the "independents," who have seen the logic of discontinuing internal strife until the industry's battle has been won, are rewarded by being called traitors by their former associates; but they must get some personal satisfaction from their efforts in behalf of the whole industry, just as the big majority of the industry appreciates what they have done.

Death—Injuries

From the humanitarian view point it might be said that the continued active interest and support on the part of oil industry executives of safety and accident prevention work is an admirable thing. That is all well and good.

Turn the spotlight on the work and inspect the results and it is found that accident prevention pays dividends. It is an economic necessity. The financial returns are worth while. So industry supports it, and gladly. Even during the past three or four years of depression, when operations recorded in black ink instead of red have been scarce, and when oil company dividends to an inestimable number of stockholders have been scarcer, no aggressive concern has disbanded its department of accident prevention and safety.

Time was when the safety organization shook in its boots upon the approach of hard times and joined in prayers with the departments of personnel supervision and public relations—for the axe fell upon those three earliest. But not so during this depression. The industry has continued to pour sums of money that cannot be estimated into accident prevention organizations, into safety, first-aid, accident and fire prevention equipment. And with good results.

During the past year the industry has been called upon to employ thousands of new men—and no doubt the majority of them untrained. These men were not only not used to oil refinery, field, pipe line and marketing division processes and practices, but were also untrained in safe working methods. Under such conditions it was inevitable that there be an increase in disabling injuries. The marvel of current estimates is that there was a decrease in the number of fatilities during 1933.

The Department of Accident Prevention of the American Petroleum Institute rightly attributes an increase in accident frequency rate among petroleum workers in 1933 to the readjustment of working forces to meet changed conditions in the industry. The preliminary reports show an increase of 5½ percent in the number of disabling injuries. There was, however, a decrease of 3½ percent in the number of fatalities as compared with the previous year.

Reports of injuries during 1933 have been made by 24 companies which had not kept complete records in former years. Late in April reports had been received from 121 companies showing accident experience for the year among 230,000 workers. On the basis of reports now available, one worker among 31 suffered a disabling injury during 1933, and one out of 1,876 was killed. In 1932 the rate of disabling injuries was one out of 32, and the number of deaths was one out of 1,810. Notwithstanding the slight increase in the number of injuries in 1933, the striking effectiveness of accident prevention programs among oil companies is shown in comparison with 1927, when one worker out of 11 was injured and one out of 1,476 was killed. These figures are for all divisions of the industry, oil field, pipe line, marketing, as well as refining. It will be interesting to study the final statistical resume of the accident experience of 1933 as it applies to the various divisions of the industry and as it compares with previous experience.

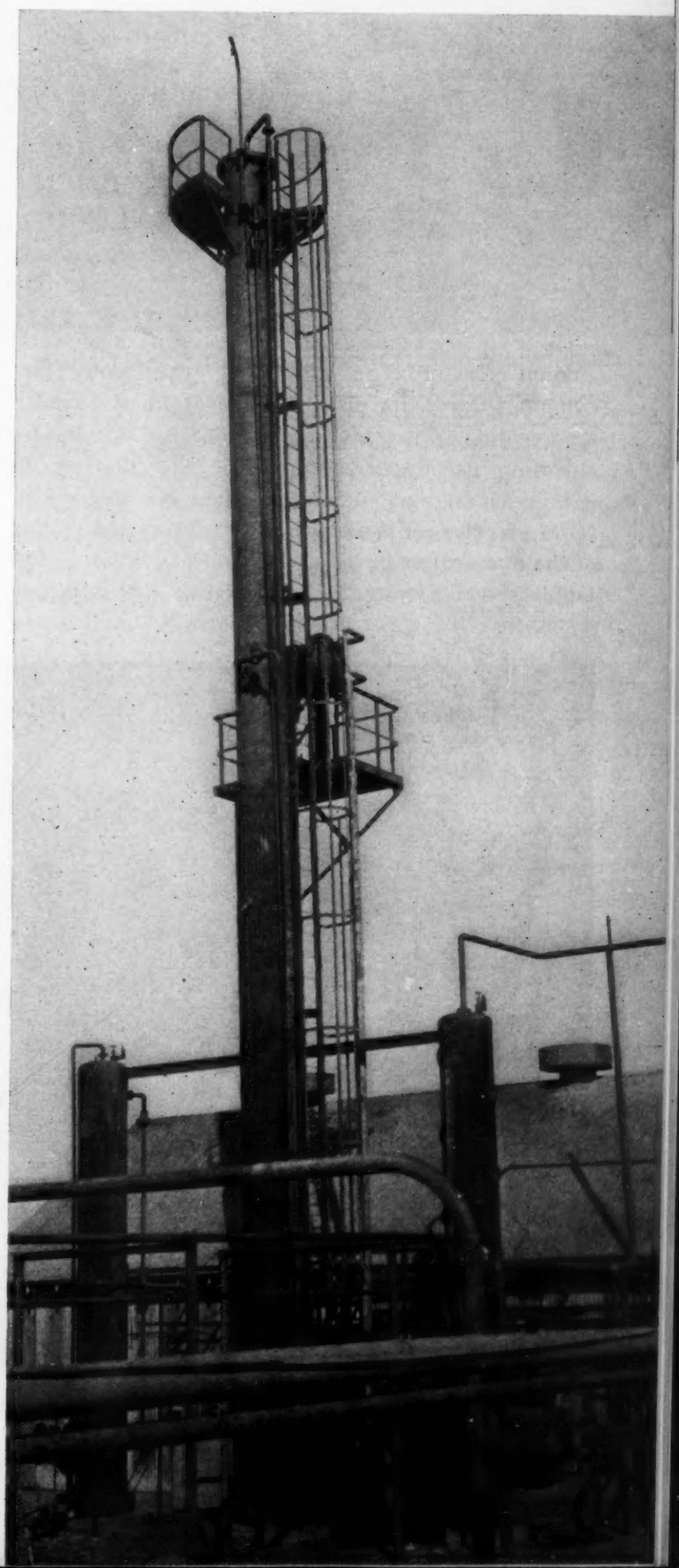
Combined Vapor Recovery and Stabilization System

J. C. ALBRIGHT

SEVERAL novel features of design and operation are incorporated in the new vapor recovery and pressure distillate stabilization system operated by Bell Oil & Gas Company at Grandfield, Oklahoma. The process differs from the usual installation in that no process steam is used in its operation, no absorption oil is recirculated, and no distillation unit or still is used in which the gasoline recovered from refinery gases is stripped. In this unit all heat is supplied for the vapor recovery columns and the pressure distillate column from the rectifying tower of a cracking unit, and a stream of oil for absorption purposes is supplied from the same source. Through a combination of various units, assembly has been simplified.

This plant, which was designed by Burrell-Mase Engineering Company, is not strictly a vapor recovery unit, nor simply a pressure distillate stabilizer, but represents a merging of the two into one system in which the operation is such that both process steps are carried out at the same time. Gasoline in the refinery vapors is absorbed in an oil which almost at the same time is fractionated to remove such propane as it has absorbed from the vapors with which it has been brought in contact. A gas engine-driven compressor fitted with tandem cylinders is used to handle the refinery gases. The system of three towers consists of a combination absorber and depropanizer with the absorption section mounted above the pressure distillate depropanizing section; a "butane flash" column and a "heavy cut" fractionating tower. This system of towers will be described in detail later.

The vapor recovery system uses two side cuts or fractions from the main fractionating column of the Dubbs cracking plant, one cut being used for heating purposes and the other cut, after being flashed in one of the smaller towers, is used as absorption oil. This practice marks the principal difference between



Vapor recovery plant at Bell Oil & Gas Company's Grandfield, Oklahoma refinery, showing the three columns. Right, "heavy cut" fractionating column; at the left is the "butane flash" column, and in the center the combination absorber and pressure distillate depropanizer column.

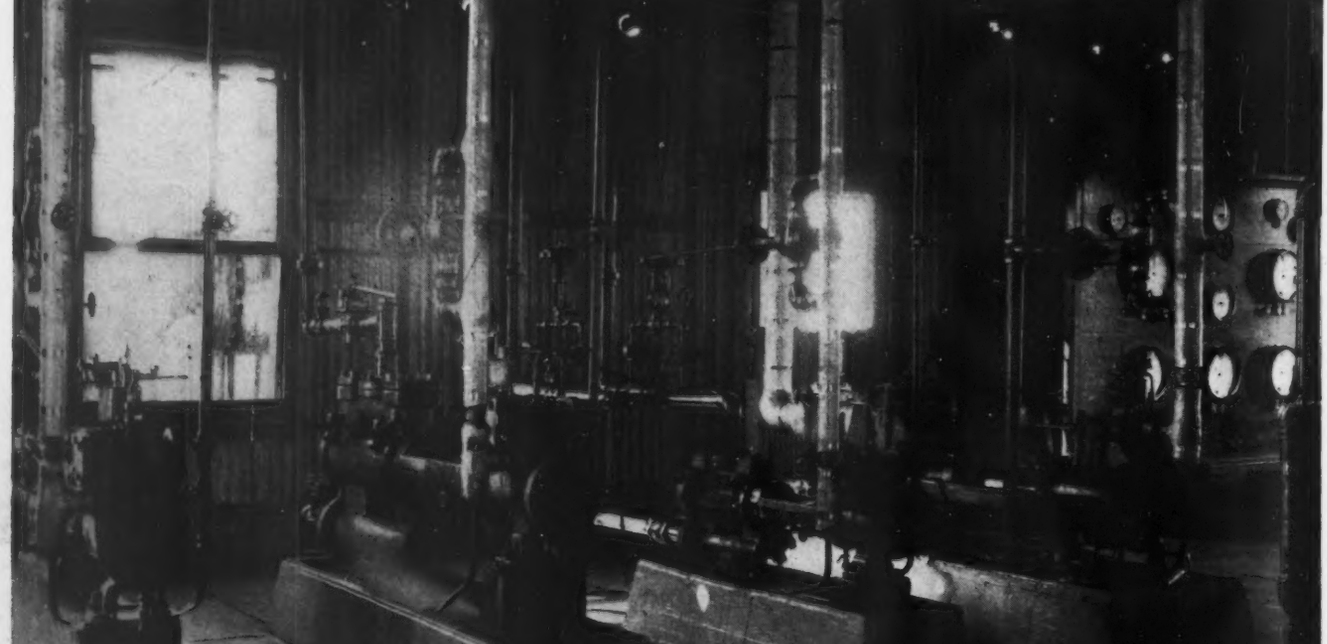
the system under discussion and the usual type of vapor recovery unit. Another departure from standard practice lies in the fact that the absorber is a continuation of the still, if it may be so termed. Actually the still is practically a precise fractionator. The column is 70 feet high, with the upper section containing gas stripping plates. The lower section is the fractionating column where propane is removed from both the pressure distillate and the gasoline recovered from the refinery gases.

FLOW OF ABSORPTION OIL

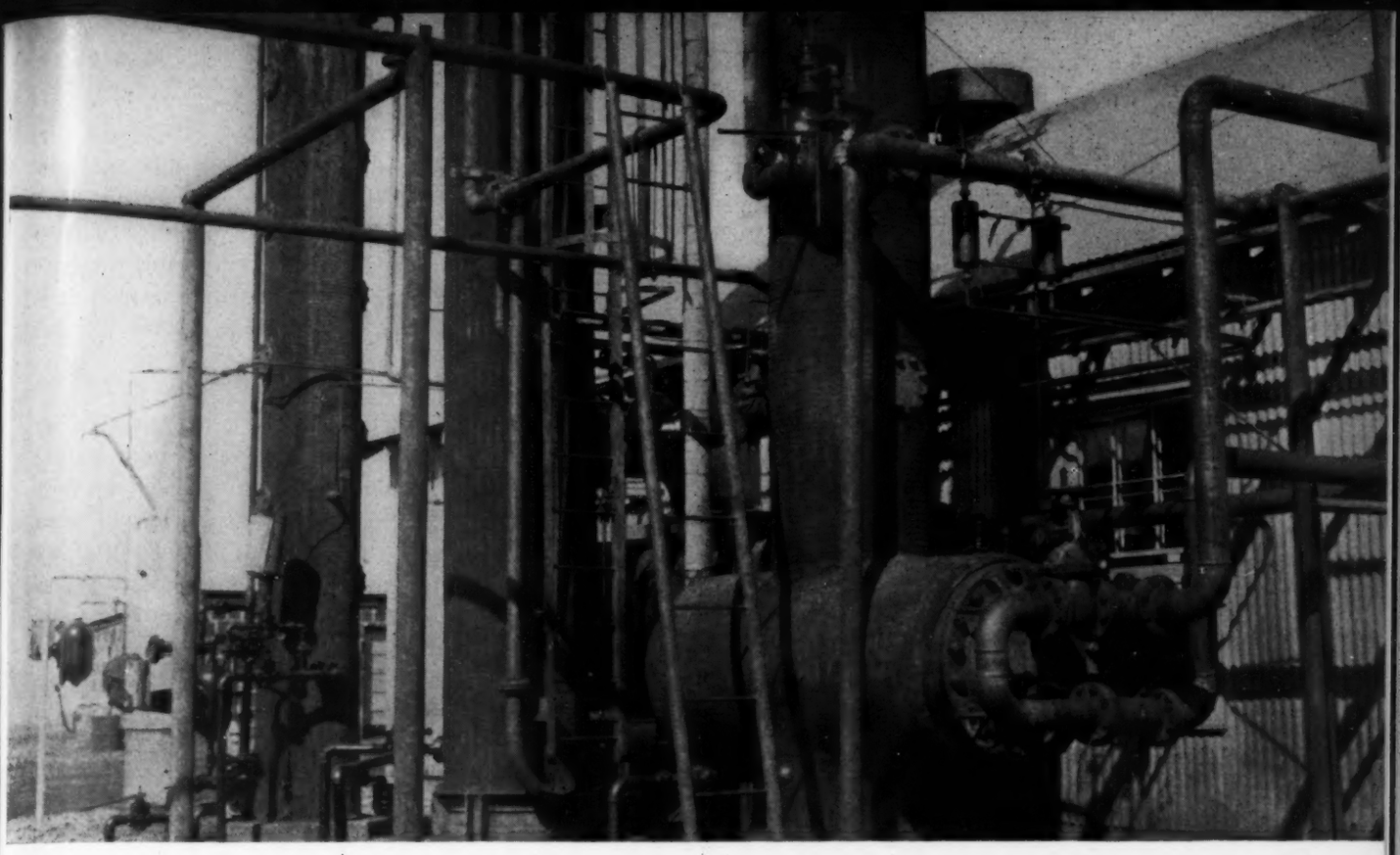
In discussing the operation of this plant it will be well to trace the flow of the absorption oil from its origin through that part of the vapor recovery-pressure distillate rectifying unit erected for its preliminary preparation to the absorber. The absorption oil is simply a heavy cut of pressure distillate removed from the main column of the cracking unit. It is removed from the tower at a point above the top bubble plate through a line inserted in the tower shell. This line removes about 30 percent of the total amount of material passing through the Dubbs plant column as pressure distillate. Naturally it contains a percentage of low boiling fractions not suitable for absorbing gasoline, and to prepare it for that service it is essential that such low boiling constituents be removed prior to its entry into the absorption section of the main tower in the vapor recovery system. The Dubbs tower operates at a pressure of approximately 58 pounds, which is sufficient to force the fraction removed from the side over to the first column of the vapor recovery unit where it is stripped of its light ends.

To heat the fraction removed and to eliminate the light ends, heat is applied through a bundle of tubes placed in the base of the stripping column. The heating medium employed to effect distillation of the light ends from the absorption oil is another fraction taken from the main column of the Dubbs plant. This heating fraction is removed from the tower at a point about midway its height. It is removed from an accumulator pan in the tower and pumped through the coils in the reboiler by a duplex steam-driven reciprocating pump. The absorption oil fraction removed from the higher point on the Dubbs fractionating column is sufficiently heated by the hotter fraction passing through the tube bundle in the reboiler that the base product removed from the stripping tower ranges about 250°F. initial boiling point and with an end point of 400°F.

Another innovation in the design of this system is found in the fact that no process steam is used in this stripping column to agitate the material in the bottom section. Steam is a valuable commodity at this refinery, not only because fuel gas is expensive when purchased, but also because of the extraordinary hardness of the water produced from wells in this part of southern Oklahoma. Therefore to conserve steam as well as fuel gas, a small stream of



Pump room and control house at the vapor recovery system.



Details of lay-out at the bases of the columns used in the recovery unit.

residue gas from the outlet connection of the combination column in the vapor recovery unit is introduced into the base of the tower where steam would ordinarily be applied. The desired agitation and turbulence of the material in process is secured by the use of this gas, which passes upward through the column to blend with the heavier fractions removed from the oil. No absorption takes place because of the high temperature of the base products and because of the absence of such fractions as would likely be picked up if the oil was cold.

LIGHTER VAPORS

The lighter vapors driven from the fraction prepared for absorption oil in process in the stripping column pass out through a vapor line to be carried back to the Dubbs condensing section to mix with the balance of the pressure distillate coming overhead from the main column. The base product from the stripping column is picked up by a close-clearance pump, size 6 x 4 x 12 inches, and passed through a bank of cooling sections to reduce the temperature sufficiently that the oil may be used as an absorbing medium. It is a close cut fraction but is apparently a satisfactory absorption oil under conditions of operation at this plant. The absorption oil enters the top section of the main column to come in contact with the vapors introduced in the base.

All of the gases from the skimming plant and tankage and from the Dubbs cracking unit are handled by the single compressor. One of the tandem cylinder is used to bring in the low pressure gas from the skimming plant, which is received under vacuum at the cylinder intake flange. It is discharged to the bank of condensers or cooling sections which handle the vapors derived from the stripping tower that prepares the absorption oil in the manner just described. This mixture of gas, and all of the gases from the cracking unit enters the high pressure cylinder on the compressor. Gas from the second cylinder at 125 pounds gauge, is cooled in a separate bank of coils and then delivered to the base of the upper section of the main column in the vapor recovery system. The vapors take the same route as in the usual absorption plant, ascending and coming into contact with the close-cut portion of the pressure distillate that was removed from the top plate of the main column at the cracking plant.

The oil flows downward through the column, arriving at the base of the upper section as rich absorption oil. At this point it leaves the upper section through a down-spout placed in a blind plate which prevents any material from passing from one section of the tower to the other except the descending rich oil from the upper section. As the oil enters the lower section it comes into contact and blends with the remaining portion of the pressure distillate taken off as an overhead stream from the main column on the Dubbs unit. This stream is picked up cold by a second close-clearance pump and pumped at 125 pounds pressure to the lower section of the combination tower. The blended stream of oil passes from plate to plate and when reaching the base is heated in a reboiler to remove the propane and other light

ends. This reboiler is heated in the same manner as the element in the first tower. The temperature at the bottom of the column is held at about 280°F. The heating oil is returned to the main column of the Dubbs unit. This operation prepares the combined stream of pressure distillate and absorbed gasoline for the debutanizer column, the third in the series.

COMBINATION COLUMN

This combination column has two purposes, one of which is to strip the refinery vapors of the desirable fractions, and to strip the pressure distillate of the undesirable fractions, such as propane and lighter. As this oil is heated in the reboiler of the combination column, the vapors driven from it pass upward through the plates, and if not washed down by the oil, they pass out through an opening in the side of the lower section and then to a cooling section, so that the uncondensed gas may pass to the lower end of the upper section. Condensed fractions back-trapped from this condensing drum act as reflux to the upper end of the lower section and controls the quality of the product coming from the base. Temperature control of the condensing section acts in the same manner as if reflux was pumped back over the column, and by varying the temperature of the condenser, more or less vapors are permitted to pass from the system to the residum lines leading from the upper end of the top section.

If any gas should pass through the mid-section condenser containing desirable fractions, it is again picked up by the absorption medium falling against it, and as it enters the lower section, the top of which is carried at 136°F., the process of elimination is carried out again. Dry gas finally leaving the top of the upper section is passed to the fuel lines of the plant and consumed in the furnaces of the cracking unit and boilers.

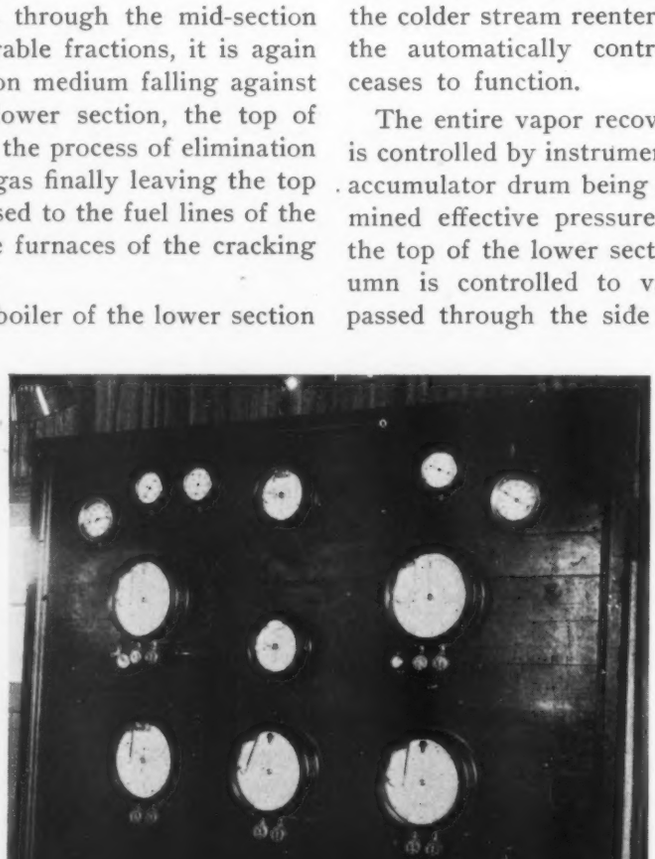
The product from the reboiler of the lower section after being stripped of the undesirable fractions, principally propane, is passed to the debutanizing column for final fractionation. Since the product is hot enough that the excess butane vaporizes easily, it is removed from an overhead line and condensed. Sufficient is taken from the pressure distillate-recovered vapors to maintain a vapor pressure of from eight to 12 pounds on the gasoline leaving the base of the debutanizing column. This material, as it is removed through float controlled valves, passes through coolers and then to storage or treating as the case may be.

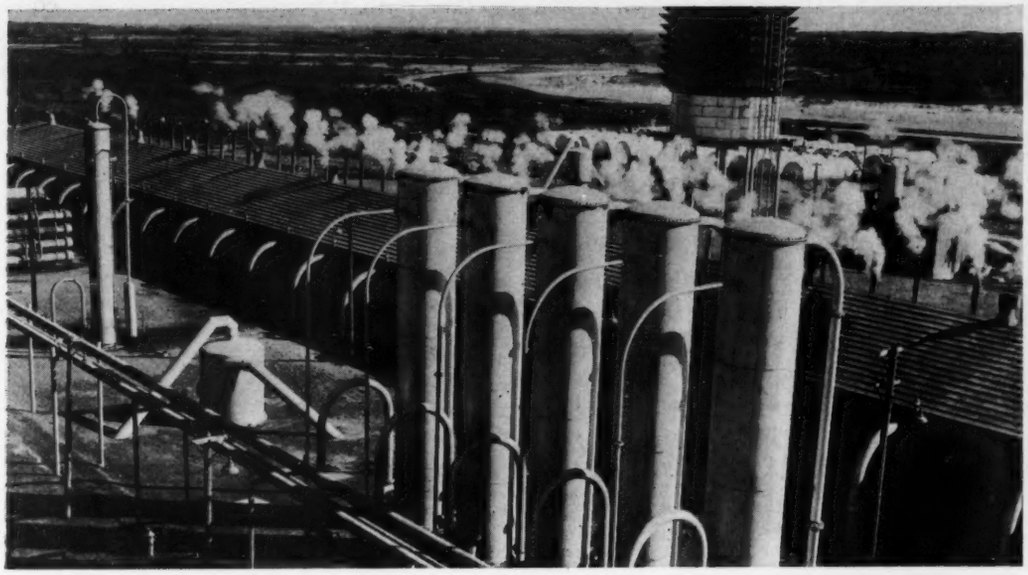
The overhead cut is taken off through a vapor line and condensed to be accumulated in a butane receiving tank or accumulator. It is picked up by a close-clearance pump having two discharge lines, both under automatic control so that the top of the butane flash column may be maintained at a constant temperature. If more reflux is needed, the valve on the line leading to the column opens, and the valve on the other line closes. Excess reflux passes through the second line and to storage where it is used in blending with low initial motor fuel, especially the lower grades.

LOWER CUT

In using the lower cut taken from the main column of the cracking plant, heat is recovered which otherwise is wasted. When the heating oil is returned to the plate next above the one where it is removed, the reflux required to maintain the proper temperature for a 400°F. end point pressure distillate is reduced considerably. At times the result of the colder stream reentering the column is such that the automatically controlled reflux pump almost ceases to function.

The entire vapor recovery and fractionating plant is controlled by instruments, the gas from the Dubbs accumulator drum being maintained at the predetermined effective pressure of 58 pounds gauge, and the top of the lower section of the combination column is controlled to vary the amount of water passed through the side condenser providing sufficient reflux to maintain an operating temperature of 136° F. The main column pressure is controlled by a similar instrument to prevent the escape of residue in excess of the required amount.





Operating Practice at Coltexo Gasoline Plant

AMONG the large number of companies who are engaged in the manufacture of natural gasoline in the Texas Panhandle, Coltexo Corporation with general offices in Monroe, Louisiana, ranks second with an average daily production of around 80,000 gallons of finished stabilized gasoline. The gasoline produced by this company is manufactured in three plants, all of which are located in Gray County and near the little town of Lefors. Plant No. 1 is situated a few miles to the east of the little village, No. 3 a couple of miles north, and No. 4 was built still farther east of No. 1.

No. 1 plant is the central unit where the district treating plant and offices are located, and the fractionating apparatus through which the production of all three plants is stabilized. Plant No. 3 includes a fractionating unit in its own yard, but without a final treating plant to sweeten the production fractionated there. Plant No. 1 was designed, as were practically all of the plants in the Panhandle in the early days, to operate with compressors bringing in the gas from the various leases, casingheads, field traps and batteries, and is equipped with 24 four-cycle gas-engine driven compressors. These power units were designed to operate against an average of 35 pounds discharge pressure and an intake pressure of about three inches, vacuum, Hg.

Through recent development of the Panhandle field, and especially Eastern Gray County, more gas has been made available for gasoline plant use and this extra supply of raw material is brought to the plant through pipe lines under natural formation pressure, and the gas introduced into the plant system headers between the compressor gas cooling sections and the absorbers. The average field temperature of well pressure gas is low enough—550°F. the year around—that it is not necessary to pass it through gas cooling sections before mixing it with the compressed gas. Under the same pressure, both are processed through the same absorbers for the available natural gasoline.

One of these lines carrying well pressure gas is several miles in length, crossing two small streams on the way from the wells to the plant, and is suspended above high water level on bridges instead of being submerged in the sandy beds with duplicate crossings fitted with river clamps as most cross country pipe lines are laid.

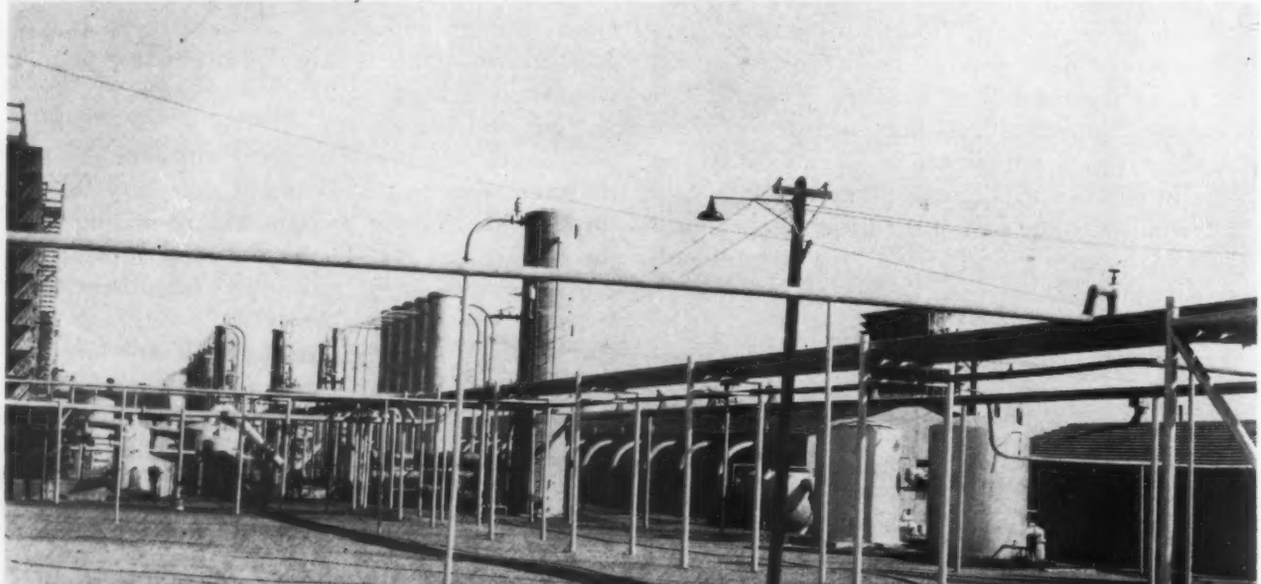
Plant No. 1 is in reality composed of two plants operated from a common engine room and service headers. Gas being discharged from the 24 compressor units and that brought into the plant system through well pressure pipe lines is distributed to two absorption and distillation units. The first unit has five absorbers and a single distillation apparatus. Shortly after this distillation unit was placed in op-

eration the capacity of the absorbers proved to be much too small to process a large additional amount of gas made available through extensions of the fields, and a second unit was constructed. The equipment selected for the extension of the plant to a two-unit operation was a four-absorber setting and a twin still, or evaporator, rich oil processing system.

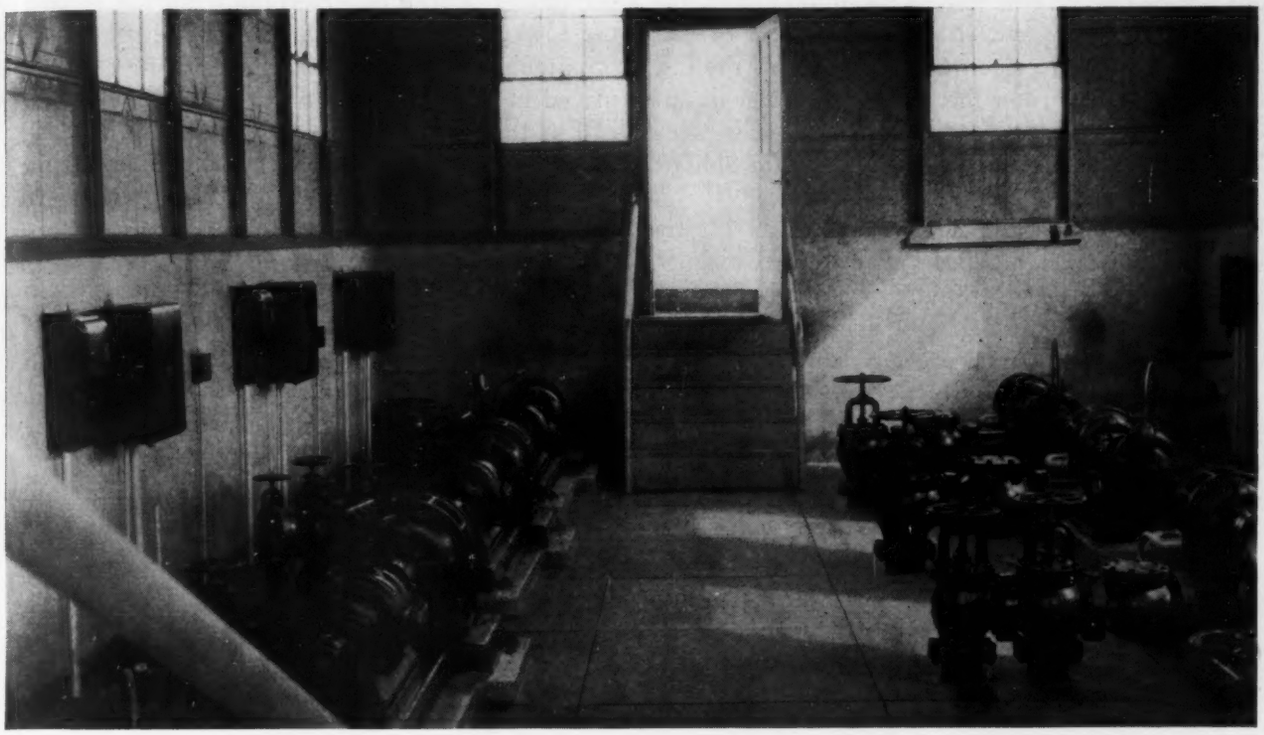
With the original unit design provided for an all-electric drive; pumps handling rich and lean oil,water and distillate being centrifugal units driven by electric motors. Three of the units were installed for handling the oil circuit, each being 2½ inch, driven by 40-horsepower motors. When the second unit was ordered built a request accompanied the order that steam pumps be used. Power is purchased outright from a local distributor, no generating station being included in the plant arrangement, but as steam was necessary for processing the rich oil, additional boilers were installed to carry the load of reciprocating steam pumps to operate the second unit.

This view toward steam driven equipment was taken principally because of the fact that a large surplus supply of boiler fuel was available above the requirements of the drilling and pumping units in the field. Instead of purchasing power, the production of steam used in the operation of the second unit does not seem so expensive; the only cost being that of depreciation, maintenance and repair, together with the operation of water conditioning apparatus. In the matter of boilers, Coltexo Corporation has found that marine type boilers give the best service under conditions prevailing in the Panhandle, and in this plant 11 steam generating units have been installed in one building, totaling in all 1400 horsepower. Six of these are rated at 150 horsepower, and the remaining five at 100 horsepower. All of them when cut in together are operated at 150 pounds gauge pressure.

Water produced in the Texas Panhandle varies in hardness and total solid content as to the locality; some of it being extremely hard such as that produced from wells in the "breaks" of the plains, while other localities, as on the plains proper, produces water naturally relatively soft. The water produced for consumption at this plant, as with the other two averages about 12 grains, and is processed for boiler make-up water through a zeolite type water softener. This double unit is housed in the same building that houses the steam generating plant, and conditions on an average of 4500 gallons of water each hour, requiring about 850 pounds of granulated salt each 24 hours for use in regenerating the zeolite beds in the double softener. A portion of the exhaust steam (as much as is practicable) is condensed and returned to the boiler house make up, or feed tank, for re-use and also to supplement the raw water being treated in the softener. This battery of boilers, in addition to



Absorption and Distillation systems at Coltexo Corporation's Lefores, Texas, Plant Number 1.



Motor Driven Centrifugal Pumps for circulation of absorption oil and cooling water.

furnishing steam for the operation of the reciprocating steam-driven circulating water and reflux pumps, also provided process steam for the distillation units of both plants. The battery also furnishes steam for heating buildings within the plant yard, for the operation of pumps and process steam for the stabilizer, and for the operation of the loading and gasoline pipe line pumps.

Going back to the engine room, the field suction header through which the gas is delivered to the compressors lays in a ditch beside the building, and the individual suction lines coming from it to the compressors were fabricated with long sweeping bends to escape construction of sharp turns, usually brought about by making up the suction systems with common ells. Swinging into the building through flanged connections, the end of the individual pipe bend comes to a point just above the intake flanges on the compressor cylinders. From this point, welded pipe bends swing over to the compressor cylinders on either side and are flanged and bolted to them. The control gates are placed outside the engine room wall, made accessible by many doors. The intake control gate is placed on a riser, flanged to it on one side, and to the sweeping pipe bend on the other as it swings into the building. To compensate for vibration and expansion of lines and engines, the upper end of the pipe bend is connected to the one inside the engine room at one point by plain end pipe couplings.

Gas discharged from the compressor cylinders leaves the building through a series of underground discharge lines to enter a common header just outside the engine room and buried in the same ditch with the intake header. Control gates on the discharge lines leading to the header are also placed outside the building and convenient to the operator, so that he can swing one open as the other is wheeled shut, or vice versa, as the need may arise. This arrangement of placing each pair of control gates outside of the room prevents an accumulation of inflammable gas in the engine room if a leak should develop, or if a gate valve stem should require packing while in service.

Each absorption unit takes its proportional part of the gas coming from the compressors, and each is provided with separate cooling towers to cool the gas from compression temperature to that required for efficient extraction of gasoline. Therefore, two main lines take off from the discharge header, each being served by a scrubber to remove any oil and condensate, before the gas enters the cooling sections. Thirty-six gas cooling sections were placed in the two cooling towers to condition the gas before it enters the common header leading to the two absorption units.

Gas coming from these two batteries of cooling sections, cooled by water that is circulated by motor driven centrifugal pumps for one unit and by water handled by the steam operated reciprocating pumps

in the other unit, runs around 55°F. in winter and about 70°F. during summer. Low humidity in the semi-arid Panhandle and an almost constant breeze, often attaining high velocities, contribute to the low temperature of the water in the cooling tower basins and the spray water as it drops from deck to deck before coming into contact with the atmospheric sections.

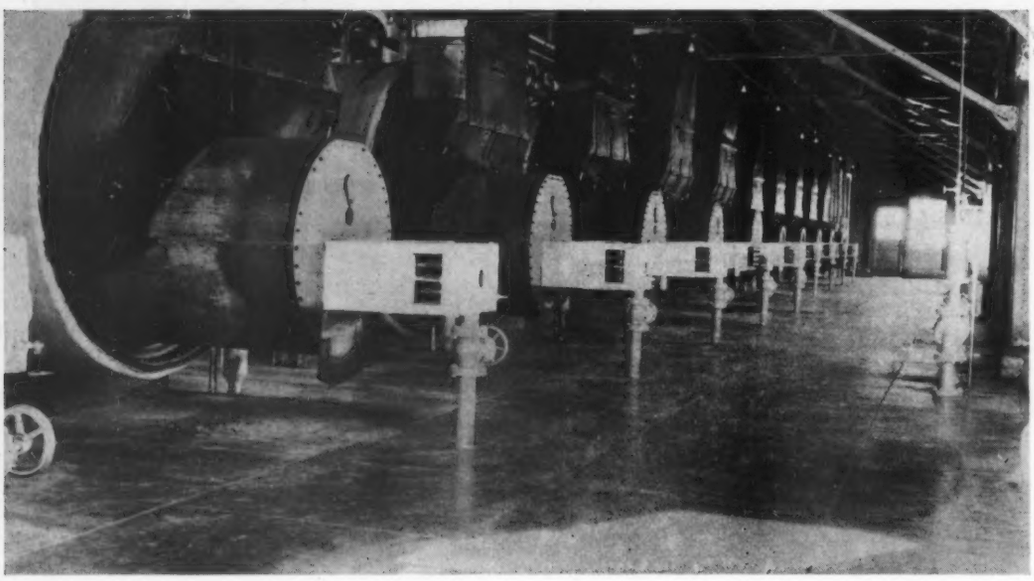
From 30 to 50 million cubic feet of gas is processed through the nine absorbers in the two units, fluctuating from time to time according to the producing condition of the fields. Under proration, the wells are off and on which prevents continuous flow of a constant average hourly volume of gas. Both the gas handled by the compressors and that coming into the plant under natural well pressure averages about the same temperature, and the residue emerging from the top of the two absorption units runs about 15°F. higher than when it entered the base of the columns.

Gas from all the absorbers is held at the working pressure of 35 pounds, and a sufficient amount is taken off this header to serve as fuel for the engine room, the boilers, and to serve as domestic fuel in the house row in which the employees live. That amount above the requirements of the plant and field consumption is transported through a pipe line to a carbon black plant a few miles away. Constant check is maintained at all times on the condition of this residue gas to determine if all the available gasoline is removed through contact with the absorption oil.

Approximatey 35 gallons of mineral seal oil to the 1000 cubic feet of gas is required to extract the desirable fractions from the gas under the temperature and pressure encountered in processing. In the first unit the mineral seal oil is picked up by a 2½-inch centrifugal pump, attached to and driven by a 40-horsepower electric motor in the lean oil circuit, and delivers it through atmospheric coolers to the absorbers. The lean oil emerging from the sections in the tower is cooled down from a still outlet of approximately 335°F. to about 68°F. Five absorbers placed in the unit receive the oil through the upper end of the shell through long pipe bends.

Rich oil from the base of these absorbers is picked up by a companion centrifugal pump which transfers the fat oil from the absorbers through the nine heat exchangers, and then through three preheaters to the single vertical still. Vapors driven from this tower pass from the shell near the upper end and are carried through an uninsulated vapor line to the cooling tower where they pass through a primary condensing section. As the heavy ends in the gasoline are condensed in this section, both the gasoline and the vapors enter a primary run, or accumulator tank, from which a portion of the liquid is picked up and pumped back over the still to maintain a top temperature of 230°F. for end point control of the gasoline. The remainder of the vapors pass through the secondary sections where the lower boiling fractions are accumulated in a secondary run tank, and the two cuts, that contained in the primary accumulator and the lower boiling fractions are blended and passed to storage.

The second system is operated in approximately the same manner, the oil from the absorbers dividing and is distributed by pumping with the steam driven reciprocating pumps to the twin evaporators, and the vapors from overhead converging in a common vapor line leading to a bank of primary condensers. This product accumulates as a cut of higher boiling fractions for refluxing the evaporator columns to maintain end point control of the finished gasoline. The secondary condensing section finishes with the lower boiling fractions not condensed while the vapors were passing through the primary con-



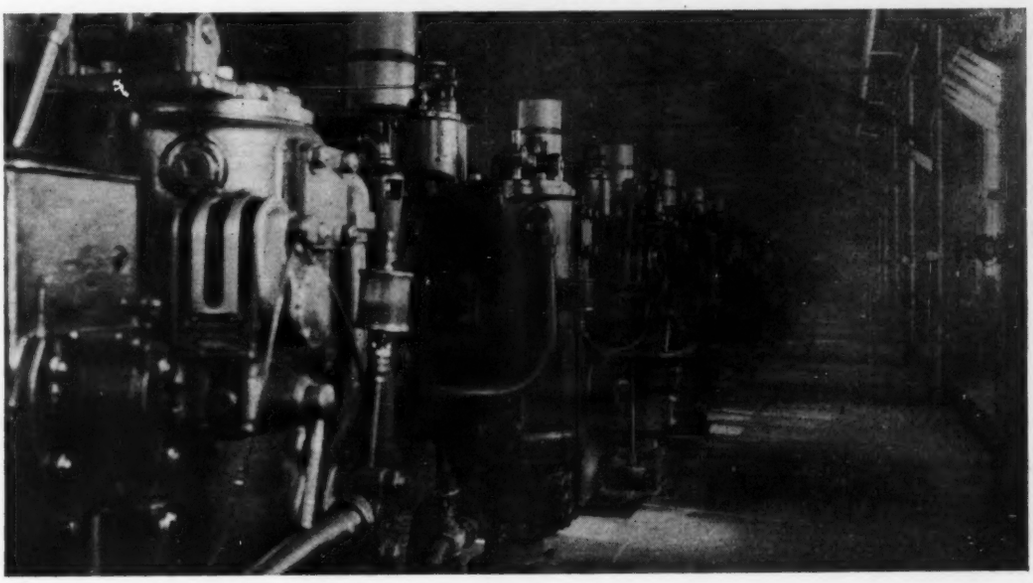
Marine Type Gas fired boilers are used for generation of steam for power and process work.

densing sections. The production from both plants, is not kept separate either before or after stabilizing to the desired vapor pressure.

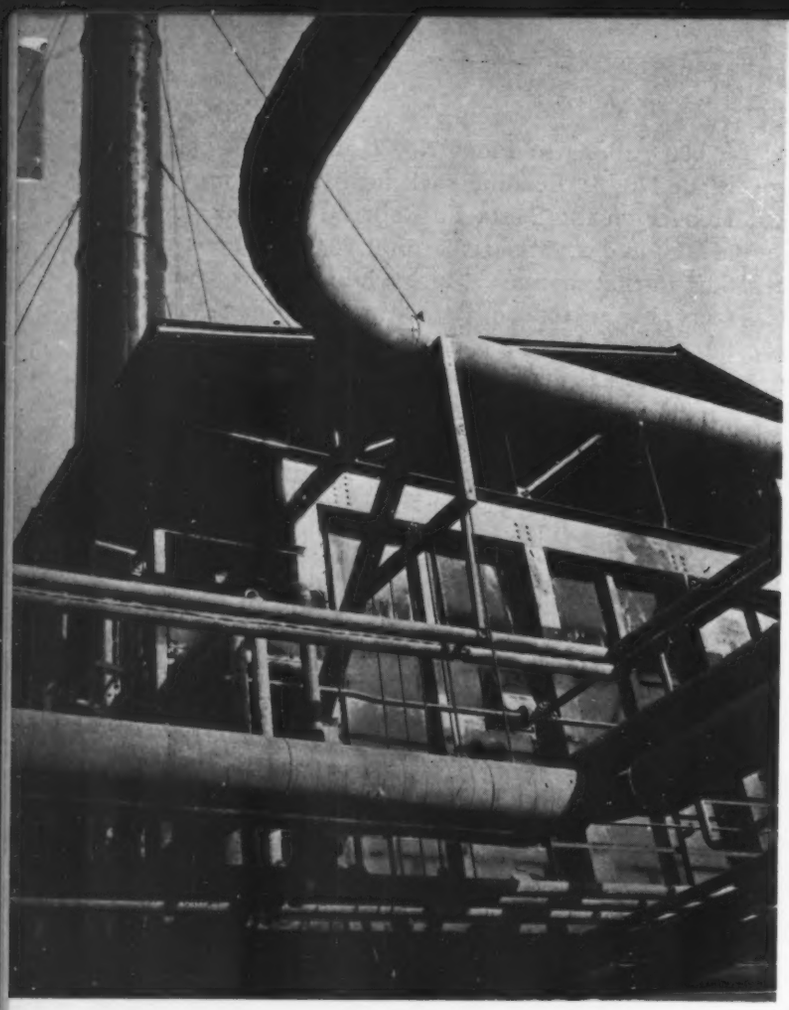
The gasoline manufactured in Plant No. 4, the well pressure plant, is all pumped to No. 1 for fractionation, treating and final preparation. A single fractionating column reduces the raw gasoline, as manufactured, to the desired grade. This column, three feet in diameter by 44 feet seven inches in height, contains 24 bubble trays with caps. Only two points of entry for the raw material were placed in the side of the column, one on the eleventh tray and the other on the seventh tray, counting from the top. The raw material from No. 4 plant runs pretty close to 70 pounds Reid, vapor pressure, and that manufactured in No. 1 averages close to 45 pounds, Reid. The gravity of the combined raw feed to the stabilizer averages 93° A. P. I., while the finished product—when running to 26/70, is held as close as practicable to 87.5° A. P. I.. When running for a lower vapor pressure product, the gravity varies somewhat as to the vapor pressure. Ordinarily, when the fractionator column is being operated for the production of a 26/70 stabilized natural, it is introduced to the shell of the column through the seventeenth tray, and the top temperature maintained at 175°F. Kettle temperatures are held at 250°F., and the column pressure is maintained at 200 pounds. When necessary to manufacture an 18-pound product, the raw feed is introduced upon the eleventh tray, and the temperature of the overhead stream maintained as before. The kettle temperature is not changed, but the column pressure is reduced from 200 to 150 pounds.

The total production from all three plants is handled through the storage batteries of Plant No. 1, treated to sweeten and prepared for marketing. Between 10,000 and 12,000 gallons is produced in Plant No. 4, 40,000 gallons in Plant No. 1 and 30,000 gallons in Plant No. 3. Loading rack facilities are provided at Hoover on the Santa Fe Railroad for tank car shipments, and a part of the total 80,000 gallons is handled in that manner. Since Phillips Petroleum Company has extended its natural gasoline gathering lines throughout the Panhandle field, Coltexo Corporation has been shipping a large portion of its product in that manner. All of the gasoline picked up in pipe lines is transferred directly to Phillips Petroleum Company's central treating plant at Borger, reduced to the desired grades or fractions, blended and shipped by pipe line to points east and north.

Another thing of interest the Coltexo Corporation is doing at its No. 1 plant, is operating the twin engines at a very low cost. A system of accounting has been installed to keep an accurate record of the individual engine, showing the application of any part, the cost of same, and when the year has passed the plant foreman has in his office a detailed statement showing just how many of each part he has used during the year. For instance, during 1933, the total cost of material and repairs totaled $1,004.78, and the oil consumption totaled $1,900.41, making a total of $2,911.19. This divided between 24 twin gas engine-driven compressors made each unit cost approximately $41.82, or a little over 11 cents per day. The oil consumed for each engine, the total divided by 24, showed that each unit consumed $79.18 worth of lubricating oil, or only about $0.22 in lubricating oil per day. Each engine therefore cost to operate for a year an average of $121.01, or only $0.33 per day, for lubricating oil and repairs and maintenance. This is brought about by maintaining the units in first class condition at all times, not waiting until they require an extensive overhaul, but doing the things when they need to be done.



Engine room, Coltexo Corporation at plant number one, Lefors, Texas.



Refinery Engineering

H. R. SWANSON
Vice President

M. B. COOKE
Director of Research and Development, Alco Products, Inc.

DEVELOPMENTS in refinery engineering have been so numerous during the past few years that it is difficult to survey the field and quickly concentrate into a short summation the so-called major points. While all refiners have common problems and are consequently interested in their solutions and methods of solution, not all developments in the refining field are of universal interest. No attempt will be made to narrate the historical in view of the interest already shown in the up-to-the-minute developments which are, for the most part, the outgrowth of the research laboratory and differ from research only in the relative scale of application. If we start with research as the father of development. it is believed Kettering's definition is concise and to the point. He said, "The purpose of research is to answer three questions: Where have we come from? Where are we? And where are we going?" These questions cover the entire field of not only research but also of development and subsequent commercial application.

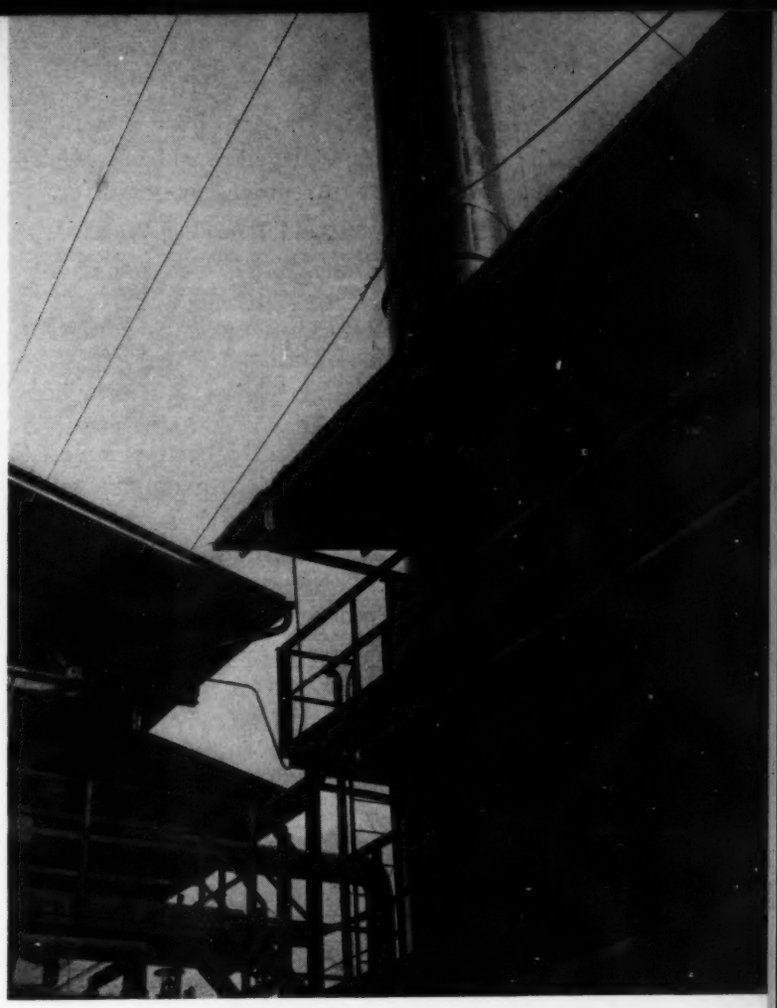
For convenience in presentation we have decided to present our ideas of modern developments in the order of the natural flow of crude oil from the field and through the refinery so far as possible. The first subject which occurs to us as worthy of serious consideration is the stabilization of crude oil at the well or in the course of its route to the refinery.

STABILIZATION OF CRUDE OIL

We are all familiar with the efforts and large amounts of money which have been expended during the past 15 years with the view of reducing the losses of volatile constituents of crude oil before refining. Among the major items which may be mentioned are steel tankage replacing wooden; different types of breathers and floating roofs; vapor recovery plants; insulated tanks and water sprayed tanks. At the same time efforts have been made to reduce corrosion of storage equipment due to hydrogen sulphide. It is now recognized that pre-stabilization of the crude will accomplish these results, and in addition, at no additional cost for fuel oil, salt and b.s. can be largely eliminated. The elimination of salt and b.s. from crude greatly reduces corrosion of primary distillation equipment and also cuts down wear and tear on pumps and meters, and tends to eliminate the solids which appear in the residue from subsequent distillation operations, a very important consideration in the case of cylinder stock production. The elimination of hydrogen sulphide is an important item if it is realized that this gas causes the loss of volatile hydrocarbons when it evaporates from the crude due to its high vapor pressure. The losses entailed by corrosion by this gas are large and in some instances the hazard of explosions is suffered in storage tanks. The removal of b.s. and salt prior to distillation, has a greater beneficial effect in permitting smooth control of distillation equipment than is generally realized. Major benefits of pre-stabilization of crude are also reflected in the con-

Developments

Before Western Petroleum Refiners Association



struction costs for new refining equipment due to lower costs for crude storage, and vapor recovery plants are unnecessary for gathering vapors from storage tanks. If the pre-distillation or pre-stabilization is practiced at the refinery, the latter becomes less susceptible to climatic changes and warmer water for cooling purposes can be tolerated, safety of operation increased and the investment is soon paid off in savings in refinery operations.

The one obstacle to pre-stabilization of crude oil in the field has turned out to be one which is not technical but legal. The present laws and regulations are such that the separated gasoline from the stabilizer, as well as the crude, take higher transportation rates to the refinery than the original crude. This feature of the regulations and laws should be changed if industry is to benefit from this development and if the natural resources of the country are to be conserved to the highest degree.

PRIMARY DISTILLATION EQUIPMENT

During the past eight or nine years we have witnessed the greatest advance in distillation that has ever taken place in the whole history of the petroleum refining art. Even with this well-known advance in heaters and fractionating equipment we are not satisfied, and improvements during the past year are worthy of note. Refiners were not satisfied with a pipe still and fractionating tower—a demand for refinement in design resulted in new developments. During the past two years many units, for fractionating crude oil into several products of desired boiling range, have been put into operation to produce results unthought of five years ago. As an example, first we will mention a unit built in Grozny, Russia. Table 1 shows the distillation characteristics of the streams regularly drawn from the atmospheric stage.

Table 1—Grozny Atmospheric Data

Date	Gasoline E.P.	Naphtha I.B.P.	Naphtha E.P.	Kerosene I.B.P.	Kerosene E.P.	Gas Oil Atmos. and Vacuum Composite
Nov. 9	320	327	387	414	581	536 34% @ 572
Nov. 10	327	333	405	417	597	
Nov. 11	309	325	396	406	588	
Nov. 12	315	327	392	421	588	
Nov. 13	307	324	390	408	576	
Nov. 14	316	333	399	419	592	
Nov. 15	316	322	387	406	579	
Nov. 16	316	331	390	403	583	
Nov. 17	315	327	394	403	574	
Nov. 18	309	327	396	405	576	

By Engler Distillations.

It should be borne in mind that the naphtha and kerosene streams are removed through stripping towers whereas the gas oil from the atmospheric stage is direct from a plate without stripping and combined with the overhead vapor stream from the vacuum stage.

Another unit proven to be highly developed and correctly designed is located at Midland, Michigan. This single tower unit was designed and built for a Mid-Continent refinery to produce narrow boiling range solvent naphthas. Table 2 shows representa-

tive test data. The crude charged was from Michigan and was pre-treated to remove excess sulfur.

Table 2—(Midland Data)

Solvent			Painters Naphtha			Stoddard Solvent		
I.B.P.	90%	E.P.	I.B.P.	90%	E.P.	I.B.P.	90%	E.P.
100	254	290	229	286	318	305	368	399

Bottoms			Bottoms	
I.B.P.	90%	E.P.	I.B.P.	5%
378	452	470	440	450

Another unit which has recently been completed and put into operation is located in a Pennsylvania refinery.

Table 3 shows representative data obtained from this unit.

Table 3—Pennsylvania Unit

Crude Unit	Gravity	Color	I.B.P.	90%	E.P.
Overhead	66.5	26	94	292	320
Solvent Side Stream	52.9	..	315	358	390
Kerosene	46.5	..	395	...	539
"300 Dist."	40.7	..	503	...	639
Gas Oil	36.4	..	600	...	712
Long Residuum Bottoms 82 S.S.U. at 210°F.					
Rerun of 66.5 Stream 23% Crude					
Overhead	73.5	30+	86	223	246
Side Stream	62.3	30+	195	249	263
Bottoms	...	..	265	...	345

The gasoline stream is rerun in a bubble tower equipped with a steam preheater and reboiler. Three products result from the rerun tower, overhead, side stream and bottoms. This unit is somewhat unusual, very simple of design and easily operated when it is considered that eight finished streams are made continuously from the crude oil distillation operation, five of which have an over-all boiling range below 500°F.

STABILIZATION OF LIGHT PRODUCTS

Stabilization, although a distillation operation may be described as a treating operation because we believe it is one of the most useful operations now performed in the refinery as an aid to treating operations. The old treating methods, employing acid particularly, were conducive to disastrous fires in refineries. Stabilization of distillates is now a necessity and not an accessory, so to speak, for all of us recognize its importance to the consumer. Vapor lock is now practically unknown while a few years ago we were sitting in our committee meetings attempting to determine who was responsible for the coughs and jitters of a lot of automobiles. The automotive group passed it over to the refining technologists and they promptly returned the "forward pass." Aside from these effects, the refiner gains enough to make the extra operation self-sustaining in most cases and in others makes a profit by being able to market specialties, such as, propane and butane, etc. Stabilization has been responsible almost entirely for the recent interest in propane dewaxing. Without cheap propane this process would have remained in the research laboratory where it has been known for years.

The design of stabilization equipment is much better understood in the past few years. We are constantly improving processes in this line and we do not feel the ultimate has been reached by any means. We have recently been called upon to design a gasoline plant, the major part of which was stabilization. Considerable time has been spent on several designs, but finally it developed that the main consideration was one of economics. As a matter of fact, based on our own experience, the main factor under consideration during these years is the economic aspect of any refinery improvement.

A few years ago designs called for removing 12-15 percent of raw P.D. as overhead in a rough cut. This left 85-88 percent to be treated. Today we are designing for 20-26 percent overhead, leaving 74-80 percent only to be treated. The latter design calls for very fine fractionation so that no material goes overhead which has to be treated. The old design will not function for deep cuts, such as 26 percent, because of lack of fine fractionation. In a plant of 10,000 to 20,000 barrels per day you can readily see the economy in cutting down the amount to be treated by 1000 barrels or more in 18,000 barrels of P.D.

Stabilization lowers fire hazards in treating, eliminates losses by volatilization, aids in the preservation of the octane rating of gasolines and in general makes the treating problem much easier than it has been. The substantial elimination of propanes and lighter permits the blending of larger proportions of butanes and heavier in the finished motor fuel without exceeding vapor pressure specifications.

CLAY TREATING DISTILLATES

Stabilized cracked distillates in a great number of cases are low enough in sulfur to meet the 0.1 percent limit for sulfur and in these cases we consider clay superior to all other treating methods. If the treating by clay is to be performed on rerun stock then it is best to first stabilize and then treat and rerun.

We have just released a paper on treating which appeared in both the World Petroleum and Refiner, dealing with clay treating and acid treating. These papers emphasize the fact that each of the three recognized clay systems, the Gray Vapor Phase, the R. K. Stratford Slurry Process and the Osterstrom Liquid Phase Clay Treating Process, has its place. Time does not permit a discussion of these processes here, but we feel confident that these clay processes will find increased use in the near future. With yields of 20,000 to 70,000 barrels per ton of clay the cost of clay fades from the picture almost entirely. Losses by any of the clay processes are negligible and the octane preservation is almost 100 percent. Color and gum stability are very satisfactory and due to the popularity of dyed gasoline, it is no longer necessary to produce 25 to 30 color gasoline. Treatment of

cracked distillates is carried out primarily for odor and gum removal and gum stability for storage.

If a distillate or portion of a distillate has to be desulfurized then we propose separate treatment by the Stratford Rapid Contact Centrifuge Separation process.

A full description of the C. W. Stratford Acid Treating System appears in the April number of World Petroleum and also appeared in the April Refiner. This process which is well beyond the development stage, is ideal for desulfurizing of distillates. Twenty months' commercial plant operation in an Eastern refinery (5000 barrels per day) has revealed that corrosion of equipment is practically nil and corrosion of rerun equipment is minimized. Only 5 to 10 percent as much SO_2 is evolved in rerunning as is obtained when the same distillate is treated in a batch agitator system. The recovery of saleable distillate is greater and the quality of the fuel bottoms from rerunning is much better and commands a higher price.

PROPANE DEWAXING

Great interest has been shown in propane dewaxing during the past two years. When an interference in the patent office is drawn with seven or eight parties, there is indicated either a valuable invention or a series of events which prompted a lot of minds to travel along the same channel. As we have stated, it was the wide adoption of de-butanizing and depropanizing units which made available propane at a low cost and at the point of consumption. Propane offers great possibilities when compared with the pentane-hexane series in use for so many years in the form of naphthas for dilution in dewaxing works. Propane, like naphtha, does not permit filtration or settling of wax at a temperature near the desired pour point of the finished oil. Its main usefulness consists of its ability to precipitate wax from dirty stocks in a condition which permits of settling or filtration whereas neither the cold settling nor the centrifuge methods will function on this type stock.

The advantages of dewaxing lube stocks by the use of propane as the solvent diluent are widely recognized. Important advances in dewaxing technique have been made through intensive study of crystal formation. One of the major advances is the recognition of the detrimental effect of excess diluent upon crystal growth. It is important not only to maintain the amount of diluent in the original blend to a minimum, but also of even greater importance to remove diluent as released by the wax component upon crystallization. If not removed, this diluent is merely in excess and retards the crystallization of waxes still in solution. This controlled process is well described in U. S. Patents 1,940,014 and 1,940,015.

Considerable progress has been made in the past year in the development of an entirely continuous commercial process. The desirability of continuous operation of all component units making up the process, over semi-continuous or semi-batch operation is obvious. This improvement should lend impetus to the more general adoption of propane dewaxing which is still one of the newer refining processes available to the industry.

Another important dewaxing method quite different from propane, is the acetone-benzol process of The Texas Company. While several investigators have worked with solvents of varying natures, acetone-benzol offers a means of dewaxing long boiling range distillates without the inclusion of any other cut, such as gas oil, etc., and at approximately the same working temperature as the desired pour point, an operation characteristic which is unique. All sorts of stocks can be dewaxed, employing a temperature of wax crystallization approximately equal to the desired pour point of the distillate.

VISCOSITY INDEX IMPROVEMENT

One of the outstanding developments of the past year has been the solvent treating of lubricating oil stocks. No one familiar with the art of refining will completely deny the superior characteristics of Pennsylvania motor oils in the past. The relatively high carbon residue and relative cost of the crude oil have handicapped the more extensive use of the oils. In order to fulfill the exacting requirements of the modern automobile engine, refiners have not lost time in attempting to solve the problem of high viscosity index and at the same time produce an oil of low Conradson carbon. The symposium at Chicago last fall served to crystallize opinion on the subject of solvent extraction of oils. While this work started with the view of raising the quality of low grade lubricating oils to Pennsylvania grade, the work has already revealed that Pennsylvania oils can be improved in quality and it will not be long before motor oils will be on the market, made from Pennsylvania stocks, which will surpass all oils in quality so far produced. This work in solvent extraction has changed the course of research and development from hydrogenation and chemical synthesis of lubricating oils to extraction work. The economics involved indicate that the two former methods of attack are not particularly attractive as money makers in view of todays' markets. Solvent extraction has added to our knowledge of lubricating oil refining and at the same time insures our country of an adequate supply of high grade lubricants for years to come. This field of development is also of unusual interest since the major portion of prior development work in refinery technology has been carried on in distillation and cracking. The solvent extraction program is the first concentrated effort shown on improvement in lubricating oils for several years.

The introduction of propane into dewaxing work

has resulted in a process whereby petrolatum stock is easily resolved into about 50 percent of high melting point wax. No longer is it necessary to throw this valuable raw material into cracking stock for the want of a better outlet.

Another interesting application of solvents in the field of refining petroleum oils is the production of exceptionally high melting point waxes from slack wax. Markets are constantly being opened up for these specialties which no doubt will find increased use in the near future.

ASPHALT MANUFACTURE

There are now three commercially feasible ways of removing asphalts:

1—By atmospheric distillation as a residue;

2—By conventional acid treating as a sludge;

4—By anti-solvent action of liquefied normally gaseous hydrocarbons.

(1) The first method is quite effective from a rough separation standpoint but due to over-lapping of boiling ranges, it is difficult to make sharp separation and the resulting break-up gives a distillate with some asphaltic materials carried over by entrainment and over-lapping boiling range and a residuum asphalt carrying some heavy oils. If the operation is carried too far cracking may result which gives further complications.

(2) The conventional acid treating is quite effective but results in an asphaltic sludge which is a combination of the products of this reaction and while it gives an asphalt-free treated oil it does not give an asphalt of any commercial value.

(3) The use of a petroleum spirit solvent is old in laboratory method and use, but has only recently been put to any extensive use commercially.

The availability of large quantities of liquid (normally gaseous) hydrocarbons has made the use of the laboratory Holde-asphalt method attractive and resulted in considerable semi-commercial separation of asphalt from crudes or crude fractions bearing the same.

The method has inherent advantages over both the distillation method and the acid-chemical method, in that both temperature effects and chemical complications are eliminated.

By the anti-solvent method the asphalt can be separated by gravity. Total oil can be recovered without the use of chemicals or heat. On the other hand, a valuable type of asphalt is obtained, being free from oil and produced without chemical or heat reaction effects and products.

A modification of the method is to use in combination with No. 2, utilizing only small quantities and even more selective re-agents, so that more effective separation can be made and at the same time the asphalt will not be contaminated or chemically affected.

By the anti-solvent effect of these normally gaseous hydrocarbons very pure heavy bitumens can be separated from asphaltic crudes and then by reblending with selected oil fractions, asphalts or bitumens of any melting point or penetration can be obtained. This has a very attractive bearing on the control of oxidation of these bitumens, as not only the amount of flux can be determined but also the characteristics of the flux oil.

CRACKING

Liquid- and semi-liquid-phase cracking processes have received so much attention during the past decade that we hesitate to take up a discussion of the developments. Most every refiner knows what the developments have been and what the units will and will not do. It is significant that the latest developments in these systems has been chiefly one of lowering the pressure and increasing the temperature. The increase in demand for high octane gasoline has been, in fact, responsible for this trend.

Among vapor phase processes, it is now recognized that Gyro is the vapor phase process in which is incorporated the latest theories of heat transfer and flexibility of operation. Any kind of cracking stock can be charged without changing the system, but in spite of this broad flexibility the operation is not decreased in effectiveness and efficiency. The reasons for this are:

1. The furnace is the most important part of a cracking unit installation and the Gyro furnace has been designed with the most careful consideration of this fact.

2. The unpopularity of the vapor-phase system of cracking was brought about by failure of the sponsors to recognize the fundamental factors governing cracking. We list them as follows:

(1) Mean effective reaction temperature.

(2) The reaction time relation to the mean effective reaction temperature.

(3) The time-temperature characteristic in general—that is, the relationship or ratio of the cracking effect in the heating tubes to the cracking effect in the soaking tubes.

(4) The temperature gradient in the vapor film at the tube walls which is governed by the film coefficient, the heat intensity and heat intensity distribution.

Alco Products Incorporated has designed, constructed and operated a new Gyro cracking unit which is representative of the design of which we are speaking. Coke formation in the tubes has been practically eliminated and smooth operation for several weeks at a time has been shown to be possible. Gas losses are now as low as competitive units due to proper correlation of the above factors and to the development of the polymerization plant, which is a part of modern Gyro installations. A paper will be released shortly in which details of design and operation will be fully discussed.

CHEMICALS FROM CRACKING UNIT TAIL GAS

A few years ago the refiner was not interested in products out of the field of motor fuels, burning oils and lubricants. Coke production was an unwelcome cousin which had to be taken care of and asphalt was in the same classification. Today the refiner is going into other lines; starting with the sale of articles in service stations, not made by him, such as tires for cars, body polishes and auto accessories, whereas the trend now is for the refiner to sell products he can make from petroleum, such as solvents and chemicals, both organic and inorganic. We believe that it will be of interest to refiners, therefore to call attention to the fact that there now are dozens of solvents and chemicals which are made from gases from the Gyro cracking still. Practically all of the ethylene glycol for anti-freeze mixtures is made from Gyro gas. A new resin, competitive with resins like Bakelite, is now being made from Gyro gas and others will follow shortly. Development work is now well along on amines, both the monamines and diamines which will increase the utilization of Gyro gas. It should be borne in mind that it is no longer true that Gyro makes more gas than some of its competitors, rather the percentage is the same based on charging stock to the cracking unit, but the composition is entirely different. Gyro tail gas contains more than 23 percent ethylene and more than 12 percent propylene and so one. The total unsaturates in Gyro gas is about 50 percent, which is two or three times as much as any other cracking system yields. This is why we can expect to see numerous commodities come from Gyro gas in the future. It is almost ideal as a raw material for the synthetic chemical industry due to its unsaturation and consequently its chemical activity. Butadiene is found in Gyro distillate and gas, and no doubt it will find increased use in the synthetic rubber field.

We hesitate to speak of war, but if it must be, the Gyro cracking unit is one of the most effective defense units used in peace time. One Gyro unit will produce enough ethylene in one day, as a by-product, to make over 40 tons of mustard gas.

We wish to call attention to the position of chemistry and the chemical industry in general, for by so doing we may be able to gain some idea of where future profits may lie for the refiner. The Federal Reserve Board on employment in December, 1933, published figures which showed that employment in chemicals and drugs stood at 107.6 percent of the average for the industry for the years 1923-1925. The significant fact is that this is the highest percentage of employment in the entire list, which includes all the principal industries of the country. The earnings were 5.3 percent of the industry's total capital and surplus for 1932, and are estimated at eight percent for 1933. Attention is also called to the reason for the position of the chemical industry by E. L. Smith, at St. Petersburg, Florida, last week. He stated "The firm foundation on which the chemical industries rest is based on their willingness to spend money on scientific research."

In conclusion we wish to point to the fact that petroleum is the world's cheapest liquid organic raw material. We should learn how to convert it into the greatest number of articles of commerce of the greatest economic value to our fellow men. Profits are sure to reward the artisans.

A continuous treating system.

SLUDGE...

L. C. TRESCOTT

THE only man who really knows sludge is the treater, particularly the lubricating oil treater. He is the last man in the line. The job can be passed no farther. With his milk bottle and his stick of white wood scraped clean with an old table knife he must and does handle tough physical chemical problems in a way which puts the doctors to shame. An acid treat may produce wonderful oil, but unless the sludge can be pumped from the agitator there can be little hope of its becoming a plant process. Many a Ph D. has acquired an added string of expressive degrees, fluently and feelingly conferred by the treating department through neglect of this point.

What is a good acid sludge? Well— it should flow with reasonable freedom. That is, it should be possible to pump it from the agitator. It should settle clear, leaving little or no pepper in the oil, and it should carry a minimum quantity of entrained oil.

The problem of keeping to a sleek, snaky sludge, free from oil is not always easy. The key point of control, once the batch is in the agitator and the acid is on, is in the water settling. It is not always possible to control the sludge from this point, either, but it is certainly possible to ruin it. Not quite enough water or agitation may leave the oil full of "pepper." Too much of either may give a granular sludge that will hold oil like a sponge, and which more than likely will freeze in the agitator. Only experience can guide in water settling. The treater develops certain instincts that tell him what is right. Further, as in his handling of emulsions, he has his bag of tricks. Any man handling experimental acid treating problems should make every effort to get such experience, for even in these scientific days a good bag of tricks is a wonderful help.

DEPENDS ON OIL

The character of the sludge depends to a great extent on the oil being treated. With the lighter oils the quality of the sludge is about the same for all. In the heavier oils, most residuals and reduced crudes will give a shiny, fast settling sludge which leaves little pepper in the oil. In handling a paraffin or mixed base oil of this nature, water settling must be used cautiously, if at all. Here the water works in two ways. It freezes the sludge, and it puts certain slimy material in the oil. Heavy distillates, on the other hand, are apt to give a sludge which is stringy, or if the water has been improperly used it will be granular.

It must be noted here that some sludges get a certain free-flowing quality from the fact that they carry a considerable quantity of free oil. It is not unlikely that many sludges from oils now being treated could not be drawn from the agitator if this were not the case. An occasional test wash with naphtha should tell the story and, as will be shown later, it may be possible to dig a considerable increase in yield out of the acid sludge.

The strength and quantity of the acid used also affects the quality of the sludge. As may be expected the stronger acids give a sludge which is not so apt to be smooth and free-flowing. With very heavy treats there is of course, enough acid present to dilute the sludge. With a few exceptions no acid which is weaker than 66° Be. is used on lubricating oils and it is this strength that generally gives the best sludge. Where an unmanageable sludge is expected the first dump of acid is often of this strength. In this way the heavy asphalts are carried down by an acid which makes them easily handled. In some cases where it is necessary to use 98 percent acid and stronger and the sludge is likely to be stiff it is possible to run in enough 66° acid at the end of the treat, before agitation is stopped, to dilute the sludge already formed. Small amounts of 66° acid or weaker acid down to about 70 percent may also be used to gather pepper where it is not advisable to use water. This not only gathers the pepper but picks up other objectionable acid residues which may be dissolved in the oil.

AGITATION

Agitation also influences the quality of the sludge formed. On the whole, too violent agitation should be avoided. While an action that literally whips the acid into the oil will give excellent contact between the two, it is also likely to put fine sludge in suspension in the oil.

While air agitation is generally used in the treatment of lubricating oils there are points where mechanical agitation is superior. It is possible to get

much closer control on a mechanical agitator than it is on a stream of air, and as the circulation is positive the contact between the acid and the oil is certainly more uniform. There are two things to keep in mind in the agitation of a treat. The agitation must give a reasonable contact between the acid and the oil. On the other hand the circulation must be such that it allows the sludge to flocculate and that it does not break down the larger particles which have pulled together. For this reason the mechanical agitator of the propeller and draft tube type is very effective. The circulation of acid is in a fairly large mass and takes place vertically instead of being just a swirling action. In continuous processes where one agitator is to overflow into another it is naturally important to have the mixture as uniform as possible and in such a case the draft tube prevents the acid from being localized.

It has always seemed that if air must be used, a central air-lift such as is used in the tall Pachucca tanks in ore cyaniding and leaching practice would give better and more positive agitation than the usual practice of extending the air line to the bottom of the agitator and letting it blow. It would also effect a considerable saving in compressed air.

With some sludges which are prone to go into suspension it has also been found that the sludge particles are coated and held up by small bubbles of air. Under such conditions the oil is naturally much harder to clear up.

The time of agitation is also a factor in sludge formation. With some residuals and reduced crudes the agitating time can only go about three minutes. The sludge pumps are started the instant the air is turned off, otherwise it will be necessary to dig the solid sludge from the cone. The average agitating time for lubricating oils, particularly when distillates are being treated, is in the neighborhood of 30 minutes. In some cases it is run to an hour or more but this longetr time is generally used on the later dumps of heavy acid treats. In many cases long agitation will put sludge in suspension. On the other hand, in cases where water cannot be used to collect the sludge, long agitation will sometimes turn the trick.

Difficulty arises in treating some oils from the fact that the amount of sludge formed is small and even though a considerable quantity of acid is used, it has a tendency to go in suspension in the sour oil rather than to go down with the acid. Petrolatums and Pennsylvania residuums are examples. This lack of sludge can sometimes be remedied by the addition of a small amount of an asphaltic residuum to the oil before treating. This will provide enough sludge to pick up the pepper from the original oil. It is just another trick for the bag.

With the coming of continuous treating for lubricating stocks the study of sludges and their separation grows more important. As a matter of fact it comes to the experimenter as a part of his problem

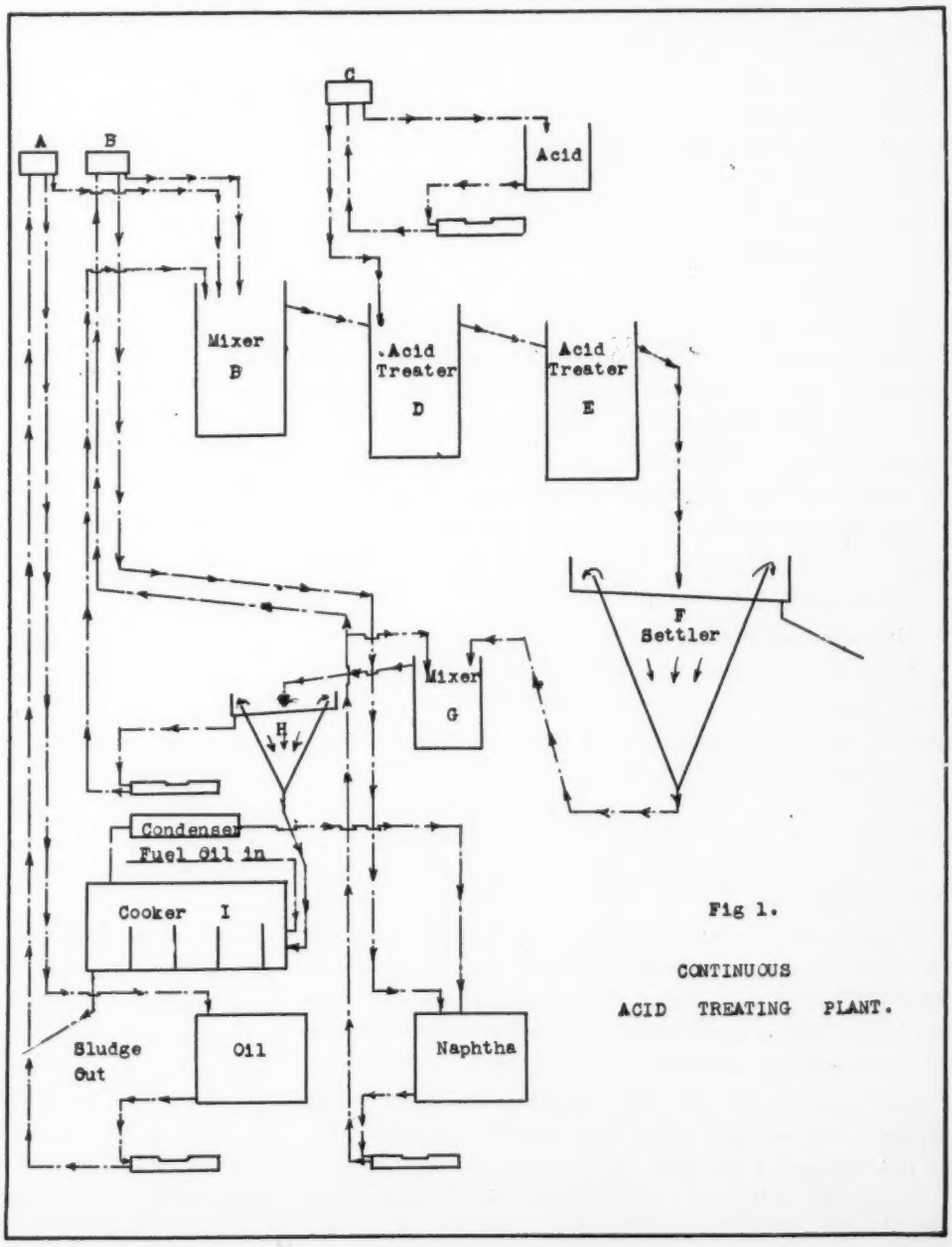


Fig 1.

CONTINUOUS ACID TREATING PLANT.

which must be solved in the development stage and not a part which he can pass on to the plant treater as is usually done in present batch processes. There is also coming into the picture the possibility of treating oils, especially heavy oils, in naphtha solution. It does not take much insight to see that such a procedure is highly desirable from a treater's point of view, but what about the economics of the proposition?

With many oils, naphthene stocks which are not dewaxed, or paraffin distillates which are pressed, it may not seem reasonable to put the raw stock into solution before treating, to handle the mix in a closed system and finally to rerun to take off the diluent naphtha. Each case will stand by itself and careful experimental work should show whether or not the increase in yield due to treatment in solution will compensate for the added treating costs; whether a change in method is really worth while.

PARAFFIN RESIDUALS

With paraffin residuals, reduced crudes, etc. the proposition is a bit different. These are dewaxed in naphtha solution in any event and it makes small difference whether the acid is added before or after. Here too the large increase in yield as well as the improved quality of the finished oil make treatment in solution especially desirable.

It is interesting to note the effect of dilution on acid treating yields. Below are some figures from the treatment of a Mid-Continent residuum. The raw stock has a Saybolt viscosity of 130 seconds at 210°F. It was treated with 30 pounds per barrel of 98 percent acid. The quality of the finished oil from all dilutions was practically the same so that the actual loss to acid must have been the same in each case. The difference in treating loss can be charged to oil entrained in the acid sludge.

The dilution naphtha was of 58 A. P. I. gravity having an end-point of 320°F. The treating losses were based on the residuum charged.

Naphtha in Solution, percent	Treating loss, percent
None	31.0
25	23.0
50	14.0
75	14.0

Such a cut in treating losses naturally leads one further. It is a method which of course must be carried out in a closed system, and which can best be made continuous, which fits very well with the modern scheme of things.

Separate treats on the naphtha solution alone show a loss of less than two percent so that there is no reason for concern on this point.

The acid sludge is very fluid and is of such a nature that it does not seem to form pepper. It settles almost instantly, leaving a clear, bright sour oil.

Here another proposition is brought in—one that can only be carried out economically where the original treat is carried out continuously in naphtha solution. It is the washing of the sludge with naphtha to recover the last of the entrained oil.

The sludge is drawn off the settler, as will be shown, and fed to a mixer where fresh naphtha is added. After a thorough mixing it is run to another small continuous settler where the naphtha carrying the good oil goes off and is returned to the system. The oil recovered here runs from four to seven percent on the stock charged with five percent as a safe average.

Going back to the sour oil—this may be finished in several ways. It may be neutralized continuously with soda, and either be decolorized with fine clay or by percolation in the usual way, or it may be given a low temperature contact treat. Finishing by this method may be either taken clear to color or just enough clay may be added to clear out the acid, the final decolorization being carried out on percolation filters.

MOST EFFECTIVE TEMPERATURE

Some years ago Paul Prutzman made the statement that the most effective temperature to apply clay for decolorization purposes is when it is vaporizing. He had in mind the higher temperatures of 600°F. and up. A series of experiments, however, brought out the fact that this is also true at lower temperatures; that a heavy oil can be decolorized at the vaporization temperature of light naphtha, provided it is in solution in that naphtha. This is advanced with no attempt at scientific explanation. It works, and that's that.

The decolorization is carried out in a series of tight agitators provided with reflux condensers. These are heated by closed steam to a temperature of approximately 250°F. It will be seen that the whole proposition is admirably fitted for development as a continuous process.

Figure 1 is a flow sheet showing the layout of the acid treating plant. Crude stock and naphtha are fed through the constant feed weirs **A** and **A′** into the mixer **B**. This overflows into the first acid treater **D**, acid also being fed in at this point through its weir **C**.

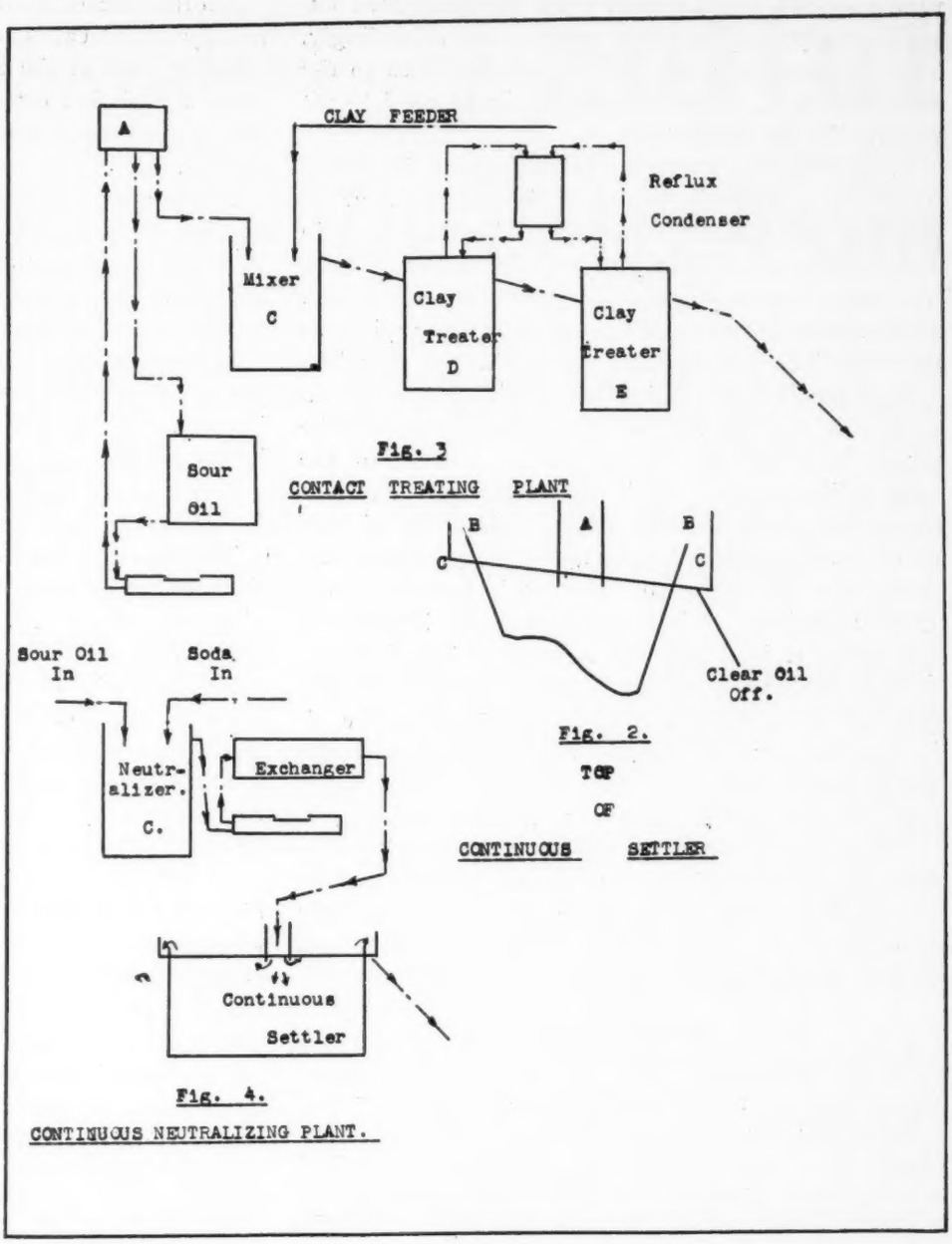
The acid treaters are closed tanks provided with suitable agitators. The agitation here must not be too violent. The propellor and draft tube type of agitator are recommended. Two treating stages are sufficient, no acid being added in the second stage. The overflow from the last acid treating stage goes to the continuous settler **F**.

The details of this settler are worthy of attention, especially the top where the clear oil is drawn off.

The periphial overflow and its launder can be applied to any sort of tank, either straight sided or conical, and has been a feature of metallurgical equipment for years.

Figure 2 represents this top. The feed goes into the settler through the feed tube A. This is usually about 12 inches in diameter and extends 12 inches beneath the surface of the liquid in the settler. Baffles may be put in this tube where necessary to prevent undue disturbance of the material settling in the tank. The sludge settles to the bottom while the clear oil rises and overflows the entire top rim, to be caught in the shallow trough or launder extending entirely around it. The bottom of the launder is about four inches below the top of the tank and is sloped to a draw-off pipe at one side. The rim of the tank must of course be leveled.

Such a method of draw-off is ideal for continuous processes. In most tanks or vessels where settling is taking place there is always, even with the slowest settling mixtures, a section at the top which is clear. It is this part of the tank's contents which overflows the rim, and going off as it does from the entire periphery of the tank there are no cross currents set up as is the case when the clear material must travel to a pipe placed at one side. It must be noted too that for a flow of 2000 barrels (50 gallons) per 24 hours the depth of flow over an eight-foot diameter tank is but .125-inch. This skims the top of the clear oil as fast as it rises.



The sludge settles to the bottom of the cone and is drawn off continuously to a small mixer **G** where wash naphtha is run into it. The overflow from this mixer goes to the small continuous settler **H,** from which the wash naphtha carrying the oil from the sludge goes back to the first acid treating agitator. This wash oil could be pumped in with the sour mix ready for finishing but it is safer to send it through the system again.

From the wash settler the sludge goes to the cooker **I,** a lead-lined horizontal tank provided with baffles. The sludge goes in at one end and is mixed with fuel oil. A little live steam is run in and the excess naphtha steamed off and returned to the system. The sludge-fuel oil mixture is pumped off for other disposal.

The clear sour oil may either go to the soda neutralization or to the contact treating plant. This is shown in Figure 3. The sour oil goes through the regulating weir **A** to the mixer **C** where the clay is run in. This mixer is of the same type as that used for acid treating. In handling clays the draft tube should be brought up fairly high in the tank. The overflow pipe feeds to the first clay treater **D.**

CLAY TREATERS

The clay treaters are of the same type of agitated tank as the other units of the system, and are provided with reflux condensers and steam heating coils. They are carried at a temperature of 250°F. The

time required for the treat may be determined experimentally and the sizes worked out accordingly. The overflow from the last clay treater goes to the filter feed tank. Heat exchangers can be used to advantage in the outlet line.

A system of continuous neutralization is shown in Figure 4. Here in the neutralizer **C,** the sour oil is mixed with soda of a predetermined strength in such a proportion as to give a slight excess of soda. The cold oil-soda mixture is pumped through a heat exchanger to bring up the temperature as rapidly as possible. The stream from the exchanger runs into a large continuous settling tank which has a top exactly like that of the settler for acid sludge. The soaps from this are drawn off the bottom of the tank while the clear oil is drawn off the top. This method of neutralization wherein the cold mixture of oil and soda is brought up to temperature suddenly and then allowed to settle is known as the Fowler method. It is covered in U. S. Patent No. 1,534,376. It is a splendid scheme to use for continuous neutralization as it gives absolute control over the formation of emulsions. Handling the oil in naphtha solution is also of advantage as the soaps settle quickly and give a very clear oil. The neutralized oil may be finished by any method desired.

Below are shown some yields on the treating of a Mid-Continent residuum in naphtha solution and by the method regularly used for this stock. An acid treat of 30 pounds per barrel of 98 percent acid was used in either case.

Treating Yields

Solution Treat	Regular Treat
86.0% Sour stock 5.0% Washed from sludge	69.0% Sour stock
91.0% 9.0% Lost to sludge	69.0% 31.0% Lost to sludge

From this it will be seen that acid treatment in a sufficiently dilute solution will show a large increase in yield over acid treatment of the undiluted stock. It must be emphasized that this increase is brought about by the fact that the sludge is given the attention it deserves and that the treat is carried out under such conditions that little or no good oil goes out with the sludge.

Another factor in increasing this yield lies in the fact that the treat is carried out at ordinary temperatures and not at the elevated temperature necessary when the oil is treated without dilution. The lower temperature treat also gives lower color and better quality.

In the contact treat for oil of regular automotive quality, 10 percent by weight of a clay such as Attapulgus XXF is used, with a contact time of 30 minutes. This will finish with a color close to 200 Lovibond and will have very good quality.

If it be desired to use the fine clay simply to rid the oil of acid then from one to three percent of clay is used. This neutralized solution may be handled in the regular way.

The solution as it comes from the filters is ready for the centrifuges and dewaxing.

The above is cited as a single example. The dilution, acid, clay and contact time may be varied to give any quality of oil desired. Oil neutralized by the Fowler method and followed by a low temperature contact treat will be of a very light color and show an extremely high resistance to oxidation. High powered clays work well with this method. As a matter of fact the large increase in yield taken direct from acid sludge will allow the use of almost any sort of processing at a profit.

In acid treating, it is not from the clear bright oil that troubles comes, but rather from that soupy emulsion or that "lousy" sludge which seems determined not to pull together, or insists on freezing before it gets out of the agitator. At the same time, if we are to improve our processing and increase yields, those improvements and those increases must come from the emulsions or from the sludges. All too many treats which show splendid quality oil fail in plant processes because the investigators fail to recognize the part that the acid sludge will play in plant proceedure. The plant treater has little time to revamp the process which comes out to him from the laboratory nor should he be expected to do so. No process should be sent out until there is every assurance that the sludge will settle, that it will run from the agitator, that it does not carry too much oil. And why not talk it over with the treater before you wish it on him? He may not have much seat left in his pants but he can handle sludge.

Methods of Determination of Sulfur in Petroleum Products

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SPECIFICATIONS for gasoline and kerosene stipulate that the total sulfur content shall not exceed 0.1 percent; in a few instances this limit has been set at 0.2 percent. Residuals, such as fuel oil, unfinished distillates, and special oils may contain more.

The ordinary practice when making a quantitative determination for sulfur is to treat the substance in some way, usually by oxidation, to render the sulfur soluble and then precipitate it as barium sulphate, which is weighed. This method requires too much time where a large number of determinations are necessary, and is expensive. Also, it is not well adapted to the examination of petroleum products.

Many years ago efforts were made to burn the oil so that the products of combustion could be collected and the sulfur content determined. It appears that A. H. Allen, in 1888, was one of the first to make use of a lamp for this purpose. The first serious sulfur problem of the petroleum industry had been introduced with the discovery of the high sulfur oils in the Lima district in 1886 and the matter of a rapid and accurate analytical method had become of considerable importance.

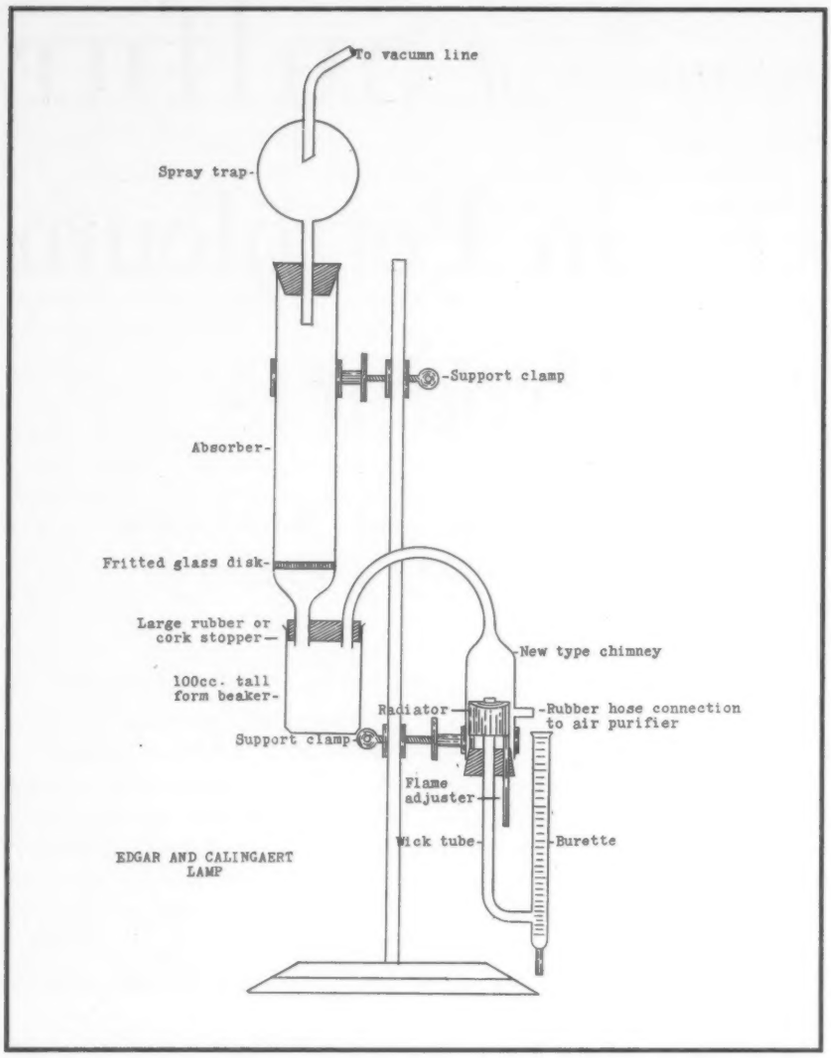
A procedure related to the present lamp test was described by W. H. Burton (Amer. Chem. Jour. 1889). His method was to burn the oil in a hot tube, through which air was passed, and to absorb the products of combustion in a standardized solution of potassium hydroxide, then after titration with acid, calculate the loss of strength of this solution. This was later improved by Burton and Robinson to what in principle is identical with the lamp test as now used. That is, a small portion of the oil is weighed in a lump, the oil is burned from a wick, loss in weight is the quantity of oil; the burned gases containing sulfur trioxide are absorbed in an alkaline solution of known concentration, then from the decrease in strength of this solution and the weight of the oil burned, the quantity of sulfur in the oil may be calculated.

Various solutions and types of apparatus have been used in a futile attempt to arrive at an accurate and dependable method of determining the total sulfur in petroleum products. These methods, for one reason or another, have failed to find a permanent place in the industry.

The standard method for determining total sulfur is one proposed and adopted by the American Society for Testing Materials. The theory of this method is excellent; under ideal conditions and in the hands of an experienced and skillful operator it will give satisfactory results, but in practical application it is liable to serious errors and several difficulties in manipulation. This method has proven so unsatisfactory that several variations and modifications of it are in general use. (See Note 1) Probably the three major objections to it are due to the construction of the burner, the questionable purity and lack of control over the volume of air passing through the absorber, and the difficulties encountered in titration.

When the lamp is lighted and placed under the chimney, the tip of the tube supporting the wick becomes hot and as the lamp continues to burn the chimney also becomes hot from radiation, heat is therefore conducted and radiated to the wick below the tip. This heat vaporizes the gasoline in the wick and tube and causes the flame to grow larger and larger as the burning continues. Inasmuch as the larger the flame the more heat is produced, the final result is either a smoky flame that discolors the absorbing solution and renders titration impossible, or the flame blows off or is sucked off at the end of the lamp. The operator must be continually watching and making numerous adjustments to secure anything like satisfactory operation.

The air used in the lamp is collected, naturally, from the immediate vicinity, and since the air in any moderately busy laboratory is of very questionable purity, the absorbing solution is open to contamination from acid or alkaline vapors, indeed, the air surrounding a whole refinery is likely to contain considerable quantities of sulphuric acid or hydrogen sulphide vapors. An attempt is made to correct for this factor by the running of a blank determination on a sulfur-free naphtha or alcohol. However, since



the quantity of air passing through each absorber may vary considerably, this blank does not mean much.

The titration is carried on in the lamp itself, using methyl orange as the indicator. The methyl orange end-point is difficult to see under the most favorable conditions. (See Note 2) and in the A. S. T. M. set-up these conditions are anything but desirable. The usual method of "boxing" the end point, that is, passing well over to the acid side and then titrating well back to the basic side and splitting the difference, is open to objection.

The many inaccuracies and inefficiencies of this method, and some of its modifications, for the determination of total sulfur have been recognized by the industry for some time but, in the absence of any better method, they have been forced to continue in its use.

Edgar and Calingaert studied the limitations of this and other methods and suggest the use of an improved apparatus which overcomes many of these faults. (Ind. Eng. Chem., Anal. Ed., Vol. 2, No. 1, page 104, 1930).

The method and lamp suggested by them has been examined and approved by the United States Bureau of Mines, (Tech. Paper 513, 1931) and is used by Ethyl Gasoline Corporation and the United States government. It is fast being adopted by the petroleum industry at large in spite of the fact that it has not yet been adopted as standard by the American Society for Testing Materials.

The analytical details of the improved method are identical with the A .S. T. M. excepting the apparatus and the indicator. The apparatus consists of a new style absorber, a radically different lamp and chimney, and an air purifier.

The indicator is made by dissolving one gram of methyl orange and three grams of indigo carmine in a liter of distilled water. This indicator was worked out and approved by the United States Bureau of Mines and is a remarkable improvement over the previous method.

The new absorber consists of a tube of Jena glass with a porous fritted glass disk sealed into the lower portion. (Described by manufacturer as a mercury filter). The tube is fitted at the upper end with a spray trap and at the lower end is connected with a 150 cc. Erlenmeyer flask or beaker, which in turn is connected to an A. S. T. M. or new type chimney by means of a rubber stopper.

The new lamp allows control of the flame and was also designed so as to eliminate the weighing of the sample, the specific gravity of the sample at room temperature being determined and the weight being calculated from the cc's of sample used. The lamp is readily adaptable to weighing if desired, and the wick may be cleaned by soaking in benzol or other solvent and drying. It may also be cleaned by filling the lamp with the liquid to be tested, placing a rubber suction hose over the end of the wick and drawing through it a few cc's of the sample. Cleaning of the wick is not necessary for routine or control purposes, being necessary only in referee or other work where it is desirable to strive for exceptional accuracy.

The new chimney is of the same general design as the A. S. T. M., the diameter is somewhat larger and allows the lamp to be placed completely within the chimney and tightly stoppered to prevent the entrance of foreign air. Chemically pure air from the

purifier is admitted to the burner through a connection on the side of the chimney.

The purifier may consist of a large glass flask loosely packed with soda lime, activated charcoal and pumice coated with phosphorous pentoxide. The soda lime removes acidic vapors, the charcoal other substances that might yield acid on combustion, and the phosphorous pentoxide any ammonia fumes that might be present in the air. One purifier may serve a whole battery of burners.

The apparatus is so arranged that the titration may be carried out in a small beaker or Erlenmeyer flask, thereby allowing a more accurate and rapid determination of the end point.

A brief summary of the advantages which may be claimed for this apparatus over the standard is as follows:

1. Lamp permits ready adjustment of the flame during the progress of the determination.

2. New type chimney allows purified air to be brought direct to the burner.

3. When burning very volatile liquids, such as casinghead, the burette and wick tube may be almost completely immersed in a 400cc. beaker filled with ice and water, thereby preventing a serious error in the determination due to evaporation.

4. The absorbing tube gives a very excellent contact between the burned gases and the solution, allowing a more efficient absorption of the SO_3.

5. The titration of the sodium carbonate may be carried out in a flask or beaker. Allowing a more accurate determination of the end point.

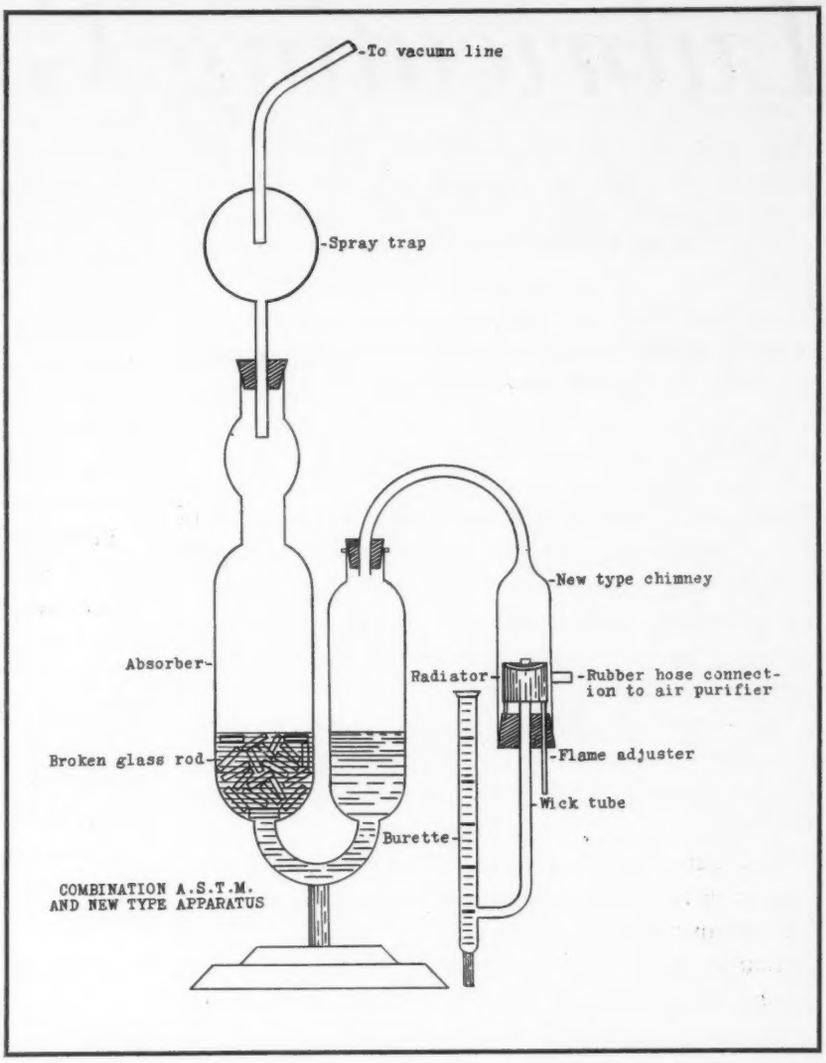
6. Results obtained are consistent and accurate to a high degree.

7. Requires less time and attention on the part of the operator.

8. The new apparatus is much more easily cleaned and is sturdier than the A. S. T. M.

Stress must be laid upon the fact that these devices may all be used together or any one or more of them may be combined with the Standard A. S. T. M. Method. An excellent and popular modification is the use of the A. S. T. M. absorber in conjunction with the new type chimney and burner.

The results of the two methods agree closely, with a very slight tendency of the new apparatus to give higher results. The designers say that the average of 20 determinations show a value about 0.003 percent higher. This slight difference is small enough to be well within the limits of accuracy as prescribed by A. S. T. M., its tendency to be always in the same direction is not accidental, and can be attributed to the greater efficiency of the absorption obtained in the new apparatus.



Note 1. Some of the modifications of the A. S. T. M. apparatus are described in the following publications:

Wood and Mattox Ind. Eng. Chem., Anal. Ed., Jan. Issue, 1930 page 24.

Chopin and Menville National Pet. News, Sept. 27, 1933, page 19.

Edgar and Calingaert Ind. Eng. Chem., Anal. Ed., Vol 2, No. 1, p. 104.

Note 2. Methyl orange is used because its indication is relatively unaffected by the presence of carbonic and other weak acids. It is very insensitive as far as color change is concerned when compared with a great many other indicators, and the results obtained with its use may be uncertain to the extent of one or two drops of N/10 acid or base.

The addition of various dyes to methyl orange help greatly in clearifying and sharpening the end point. Of these, indigo, carmine and xylene cyanole FF. are probably the most efficient.

References for Note 2 are as follows:

Thorpe Dictionary of Applied Chemistry, Vol. 1, page 58.

Journal of the Chemical Society, 121-2502 (1922).

C. K. Francis, The Oil & Gas Journal, Dec. 17, 1931, page 26.

Espach and Blade, Tech. Paper 513, Bureau of Mines, 1931.

Lubricating Greases . . .

C. C. WILCH

Lion Oil Refining Company

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(Read at meeting of technical men of Louisiana-Arkansas Refiners Association)

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LUBRICATING greases are ordinarily thought of as petroleum products of unctuous, salve-like consistencies or of a hardness describeable as semi-solid. This non-fluid type, with but few exceptions, are soap thickened mineral oils. The different soaps employed as thickeners give a wide variety of textures. Where one soap may give a buttery, short-shear texture, another, compounded with the same mineral oil will give a tough, sponge-like, long-shear texture.

This difference in outward or physical characteristic, is in many instances an all important factor in determining the suitability of the lubricant for a particular lubrication requirement. For instance, the sponge texture which denotes a high degree of internal cohesion within the grease body, is more effective than the shorter shear, buttery texture in resisting centrifugal force and channeling. Therefore, it is more suitable for ordinary gear lubrication. On the other hand, the short-shear, low-cohesion property lubricant possesses a greater resistance to flow and, incidentally, is more serviceable for long periods of duty on open type bearings.

Recently, however, greases of fluid or oil-like consistencies have become of major importance. The viscous soap oil mixtures previously used have, in many instances, given way to lighter bodied lubricants of very superior lubricating film strengths. Changes in mechanical construction and increased speed of machine parts, have introduced a need for this type lubricant.

The need originated with the automotive industry. It, alone, has called upon the grease manufacturer to build a lubricant differing from all previous requirements. The introduction of such mechanical changes as free wheeling, automatic gear shifting devices, and higher gear speeds, has necessitated special lubricants.

The highly viscous sponge textured soap-oil mixtures formerly employed, did not function properly, due to numerous reasons. In high speed transmission the very viscous lubricant was found to be unable to resist centrifugal force, and consequently, failed to establish contact with the gear face at high speed. Straight mineral oils also failed to function satisfactorily under severe lead conditions, because of insufficient lubricating film strength. Thus, we have introduced as extreme pressure lubricants, comparatively low viscosity compounds of mineral oil with various lubricating film strength builders.

For free wheeling and automatic gear shift device, highly viscous lubricants were again found inadequate, because of the resistance offered to the sliding and throw out action of the machine part. Straight mineral oils will suffice, but more satisfactory year-round performance is obtained by adding compounds to improve their viscosity-temperature relationship and to improve penetrating and spreading property of the oil on metal surfaces.

Greases in general, regardless of body texture or lubricating functions, may be classified somewhat roughly into the following four major groups:

1. Admixtures of mineral oil and solid lubricants.
2. Mineral oil residua and blends of residua with other petroleum fractions.
3. Soap thickened mineral oils.
4. Compounds of mineral oils with various lubricating film strength builders.

Lubricants of groups 1 and 2 are in every sense of the word, "specialty" products, since they have a very liimted range in the lubrication field. They are not widely used and their sales possibilities are by no means fully developed. Few of them are known by trade names such as used to identify the many soap thickened lubricants. Tractor roller greases (used to lubricate the track bearing of traction type tractors) wire rope compound, and rock bit lubricant (used in connection with oil well drilling) are some of the few familiar trade names.

The first group (admixtures of mineral oils with commonly termed solid lubricants such as graphite, mica, talc, asbestos fibers, etc.) in some instances are invaluable. For the lubrication of an ill-fitting machine part, functioning under a heavy, intermitting load and at slow speed, the filler or solid lubricant, absorbs the force of impact, preventing severe metal to metal contact. Furthermore, in functioning as a filler, the solid lubricant tends to smooth away any

roughness of contact surfaces which may be encountered.

Examples of the type are: tractor roller lubricants and lubricants for railway car unloading devices, concrete mixers, mechanical digging equipment and the like. They usually consist of viscous mineral oils mixed to the desired consistency with asbestos fibers or other fillers possessing a lesser degree of hardness than steel.

They are used for lubricating both bearing and gears. They are not adaptable for close fitting machine parts since the filler is apt to accumulate and clog the feed to a bearing or build up between the teeth of a gear and cause undue strain. However, this statement does not apply absolutely, since graphite, when used in this capacity, is of such a finely divided state or is used in conjunction with a soap thickener in such a manner that these disadvantages are overcome.

The second group, consisting of mineral oil residua and blends of residua with other petroleum fractions, possess characteristics peculiarly valuable to certain lubricating problems. Greases of this type are especially suitable for rock bit lubrication, dredges, cranes and for wire rope and gears operating under water or exposed to severe weather conditions. Asphaltic residue, as a base, is highest in favor. Its high specific gravity and high degree of metallic adhesion, affords greater protection against under water or severe weather conditions.

The lubricant is made either by reducing the crude to the desired consistency or by blending a heavy residuum with a lighter petroleum fraction. In some instances such as, with wire rope compound and lubricants for open type gears, it is common practice to blend the heavier fraction with a light volatile naphtha. The volatile portion subsequently evaporates, leaving a tenacious lubricant practically impervious to water action.

Obviously, lubricants of this type are not suitable for machines operating under conditions of high speed or light load, since power efficiency would be greatly affected in overcoming lubricant coefficient of friction.

In discussing the third group, or soap thickened mineral oil type of greases, it is the intention to cover generally, the manufacturing procedure, physical properties and the relation of physical properties to lubricating service. Soap-oil mixtures are the most commonly known greases. They are used in place of mineral oils, chiefly because they are more economical lubricants. By reason of heavier body and greater resistance to flow, less waste is encountered and the same lubricating results are obtained at a lower cost. Also a soap-oil product will lubricate for a comparatively long period without attention or replenishment.

The soaps employed as thickeners include sodium, calcium, aluminum and lead. They are the products of chemical reaction of fat (either animal or vegetable origin) with the metal bases. The metallic base, obviously, determines the type of soap, plays the major part in forming the principal characteristics and general physical properties of the grease product.

Sodium or caustic soda greases are characterized by their solubility in water, and high liquefaction temperature or melting point; calcium or lime greases by insolubility in water and instability at moderately high temperature; aluminum soap products by stability at high temperatures, water insolubility and brilliant transparent appearance; and lead soap products by high specific gravity, comparatively low melting point and much less viscous body.

The saponifiable oil or fat, in most cases, is of but slight importance to the construction of a grease product. However, the more specific properties, such as texture, metallic adhesion and the cohesive character of the grease body are controlled to some extent by selection of the fatty ingredient. But as a rule, cost and appearance of the resulting grease product, are the determining factors in the selection of the fatty oil.

The grade and body of the mineral oil incorporated, is largely responsible for the lubricating value of a soap-oil mixture. Although viscosity is by no means a true index of lubricating value, it stands unquestioned that an extremely heavy bodied oil possesses a stronger lubricating film than an extremely light bodied oil. Interesting to manufacturers of naphthenic base oils, is the claims of numerous investigators that oils of high natural sulphur content possess greater lubricating film strength than oils of either low natural sulphur content or oils to which free sulphur has been added.

CALCIUM SOAP GREASES

Calcium or lime soap greases are in demand probably more than any other soap thickened lubricant. The commonly known varieties include the several grades of cup grease, pressure gun grease, ball and roller bearing grease, axle grease and water pump grease. The greases, ranging from semi-fluid to semi-solid consistency contain from four to 25 percent soap. The mineral oil ingredient is usually a highly refined light or medium bodied grade.

Lime base products may be made in two ways and are classified, according to the method used, as cold set greases and hot mixed greases.

The cold set greases are made by simple mixing of rosin oil, lime and mineral oil. Saponification takes place and the mixture hardens without application of heat from an outside source. Rapid saponification,

cold, is peculiar to the fatty members predominating in rosin oils.

Cold set greases are comparatively inexpensive and are designed for rugged duty, where the cost of higher quality lubricants is prohibitive. Set greases are extensively used on agricultural machinery, where they are known as axle greases, and an oil field pumping equipment where they are known as jack post greases.

Hot mixed lime soap greases are made by saponifying the fatty ingredient with an accurately measured amount of hydrated lime. The chemical reaction is carried to completion in either open type steam jacketed kettles or closed type pressure cookers. The extended period of contact at elevated temperature enables the reaction to be carried nearly to completion and consequently the cooked grease has a more finished and lustrous appearance than the cold set variety.

The ordinary run of cup, pressure gun, roller bearing and water pump greases found on the market are examples of the type.

Lime soap greases are not applicable as lubricants where the temperature is apt to rise above 212°F. The grease is not a true solution of soap and oil but is a suspension of soap and water in oil and is dependent upon the water content to maintain the grease body. Consequently, at a temperature in excess of 212°F, the grease loses its moisture and a separation of soap and oil results.

The advantageous characteristics of lime soap greases are: insolubility in water, and short shear or buttery texture. The texture indicates a low degree of cohesion within the grease body, and incidentally, high resistance to flow. Flow resistance is of great advantage on bearings required to operate without attention for comparatively long periods.

The grease is easily displaced by centrifugal action, meaning that it channels readily, and therefore, it is unsuitable for gear lubrication.

SODIUM SOAP GREASES

The equipment and manufacturing procedure for sodium soap or caustic soda base greases are essentially the same as that used for lime base greases.

The grease has a characteristic sponge or fibre like texture, and, differing from calcium soap greases, shows a high degree of cohesion within the grease body. This cohesive property causes the grease to flow in a stream with the moving part. Obviously, the grease does not channel under normal conditions and is not easily displaced by centrifugal action, except at extremely high speed. The light bodied grades containing from approximately one half to six percent soap are used for ordinary gear greases (not extreme pressure). Caustic soda greases have higher liquefaction temperatures than any other type of soap-oil mixture, and consequently, the products of heavy consistency ranging from approximately eight to 50 percent soap, are used for high temperature bearing lubrication. It is this type of grease which is used in steel mills on machine parts which operate in proximity to molten metal. Various railroad locomotive greases are also examples of the type. The more commonly known products, in addition to the various grades of gear greases, are automotive wheel bearing, universal joint and steering sector lubricants.

The reason they are not more extensively used is due to the fact that sodium soap is water soluble, and consequently, its grease products do not give a long period of service where they are apt to come in contact with any considerable amount of water. Were it not for wet weather conditions, sodium soap greases could probably be used in place of lime and aluminum greases for automotive chassis lubrication.

ALUMINUM SOAP GREASES

Aluminum soap greases, compare closely in texture and lubrication adaptibility to calcium soap greases. However, they have a more brilliant transparent appearance, and far better stability at high temperatures. They offer by far the most perplexing problems in grease manufacture. Every ingredient plays a major part in shaping the physical properties of the resultant product. The aluminum soap of stearic acid, incorporated with a low viscosity mineral oil, yields a grease product of low cohesive character as evidenced by its short shear, buttery texture. The aluminum soap of oleic acid, incorporated with the same mineral oil, yields a product of extremely high cohesive character, and pronounced rubbery texture. Contrasted with other soaps herein discussed, aluminum stearate, when incorporated with an extremely high viscosity oil, yields a grease of softer consistency than when incorporated with a low viscosity mineral oil. The rate of cooling also has an important bearing on the grease texture and consisteney.

It is necessary for the grease manufacturer to make an extensive study of the mineral oil, the fatty ingredient and also the cooling rate best suited for the grade he wishes to market.

The manufacturing procedure for aluminum soap, is different from that of other soaps, in that it is a product of a substitution reaction. The fat is first saponified with caustic soda. Then by addition of an aqueous solution of an aluminum salt, the sodium radical of the soap is replaced by aluminum. The water insoluble aluminum soap separates, thus permitting the solution containing the sodium salts to be drawn off. By repeated washings, the aluminum soap is freed entirely of excess saponifying agents.

Since aluminum soap can be purchased already prepared for simply mixing with mineral oil, many

grease manufacturers do not go to the trouble of making the soap.

The greases are commonly referred to as solidified oils, transparent cup and pressure gun greases and as an all-purpose lubricant. The cost of the type is high compared with other soap-oil products and apparently its advantages as a lubricant are not sufficient to offset its higher cost since it has not made any great headway since first introduced. However, it has become extensively used on automotive vehicles as the Tryon shackle assembly lubricant. It is stable for long periods, does not oxidize or crust and has a slow flow property especially adaptable for this requirement.

LEAD SOAP GREASES

Lead soap greases are employed largely as extreme pressure gear lubricants. The soap is very deficient as a mineral oil thickener, and in fact, when blended with a heavy body mineral oil, the viscosity (measured at 210°F) may be decreased. One of the numerous early uses of the soap was for compounding into railroad car journal oil.

Lead soap has an exceptionally high specific gravity as compared with other soaps. It is apparent from observations that lead base lubricants possess a high degree of metallic adhesion, which may be the responsible factor of its excellent lubricating performance under heavy load at high speeds.

Proper selection of saponifiable oil is very important in the manufacture of lead soap. The fatty oils of the acetic or saturated series, yield lead soaps which are but slightly soluble in petroleum fractions, whereas, the lead soaps of the oleic or unsaturated series are quite soluble. Consequently, fats of high iodine absorption value yield the more oil-soluble lead soaps. Fish oils and oleic acid are commonly used.

Sulfur is commonly used in conjunction with the lead soap in manufacturing extreme pressure gear lubricants. The sulfur in some lubricants is chemically combined with the soap, and in others it apparently is physically absorbed in the grease body.

EXTREME PRESSURE LUBRICANTS

The third group, consisting of compounds of mineral oils with various lubricating film strength builders, is that classification of lubricants which originated to meet the requirements of the automotive industry.

The first in line was an extreme pressure lubricant. Higher powered motors for greater speed and changes in gear design to give more efficient transmission of power, resulted in increased gear tooth pressures. In addition to increased pressure, the introduction of hypoid and worm drive gear assemblies presented a more severe condition of gear face contact. These improved designs are such that the rubbing action is extended over a greater distance and the time element increased, since some part of the gear face is in contact with the drive over the entire length of the worm. Obviously, while this rubbing action is in progress, a considerable amount of frictional heat is generated. Under these conditions, ordinary mineral oils and greases cannot maintain a protective lubricating film.

The course of investigation and development work has not been entirely one of trial and error. It had long been known that sulfur in oil was an effective cooling agent for hot bearings, also that lead soap compounds were exceptionally good lubricants for railroad car journals where hot boxes were frequently encountered. The addition of fatty oils of any description to a mineral oil was also known to improve penetrating and spreading property of the oil on metal surfaces. Incidentally, the principal of this action is, lowering of surface tension.

With the development of adequate testing methods and equipment, it was found that lubricants of high sulfur content caused a film of iron sulphide to be deposited on the contact faces, and that this film, in cases of lubricant failure, served as a protection against serious gear scoring. This principle has been termed "border lubrication" and it is this principle upon which all extreme pressure lubricants are now built.

Chlorine compounds were later found to function in much the same manner as sulfur compounds, the formations on the contact face being iron chloride. Consequently, a combination of the two elements, "sulfur chloride" was tried with satisfactory results.

Extreme pressure lubricants now marketed by competent lubricant builders contain one or more of the above mentioned ingredients. Fat is used unsparingly, the lubricants rarely containing less than 10 percent, except in the case where lead soap is used. In fact, fat is a convenient and valuable medium for introducing either sulfur, chlorine or sulfur chloride. The mineral oil ingredient varies greatly. Some manufacturers use a crude residuum, while others are content to use only the highest refined oils. Low pour point oils of less than 140 seconds Saybolt Universal viscosity at 210° F. are generally employed. Free wheeling lubricants are as a rule low pour point well refined mineral oils containing an amount of free fat and in many instances a compound to improve viscosity temperature relationship.

To predict as to what the future trend in grease manufacture may be, let us review the trend of the past. Competition has demanded constant improving of appearance. Incidentally, ingredients have become more accurately proportioned, and cooking has developed to more and more of an art. Improved equipment, such as the auto clave or pressure type cookers, with

(Continued on page 188)

Elements of

. . . Stabilization

I. N. BEALL
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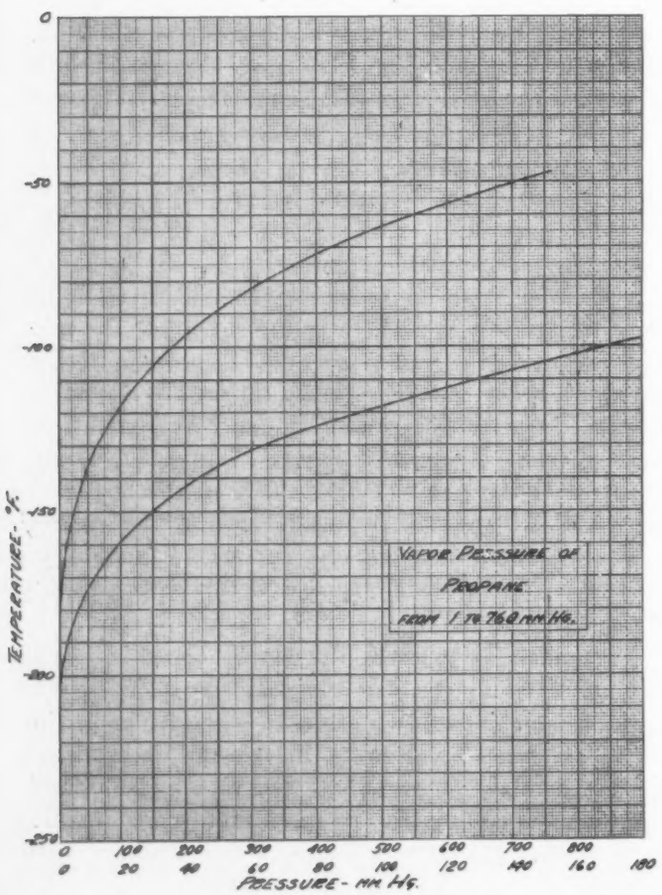
PART I

WIDESPREAD use of superatmospheric pressure rectification systems for the stabilization of natural gasoline as well as their somewhat less extended use for the separation of special fractions such as "bottled gas," propane, butanes and pentanes, etc., has occasioned considerable conjecture as to their method of functioning. The purpose of elevated operating pressure is to permit the use of plant cooling water through the overhead condensers so as to avoid the use of mechanical refrigeration. Otherwise an increase of the pressure increases the difficulties of fractionation. In other words, the separation of close fractions takes place with greater facility at low pressures and low temperatures. This is well grounded both from the theoretical and practical view point as it is based upon the volatility ratio. The volatility ratio between the components decreases as the pressure increases and it can be mathematically demonstrated that a greater number of plates are required for a low volatility ratio than are required for high volatility ratio.



PHYSICAL PROPERTIES OF CONSTITUENTS

First of all it is essential to know as much about the raw material as possible. The first step in attaining a conception of fractionation is to become familiar with the physical properties and characteristics of the components which are common to every natural gasoline or natural gas condensate. With this in view the writer has prepared tables of the physical properties of the natural gas hydrocarbons expressed in English units, that is, pounds, degrees, Fahrenheit, B.t.u., etc. These tables may be used as the basis for making charts and curves for handy reference.

An inspection of the accompanying tables reveals a number of reasons why certain separations are impractical or impossible under average operating conditions. For illustration in Table 1 it will be noted that the critical pressure of methane is 658.1 lb. ga. It is obvious that a temperature considerably below the criti-

TABLE I
Methane

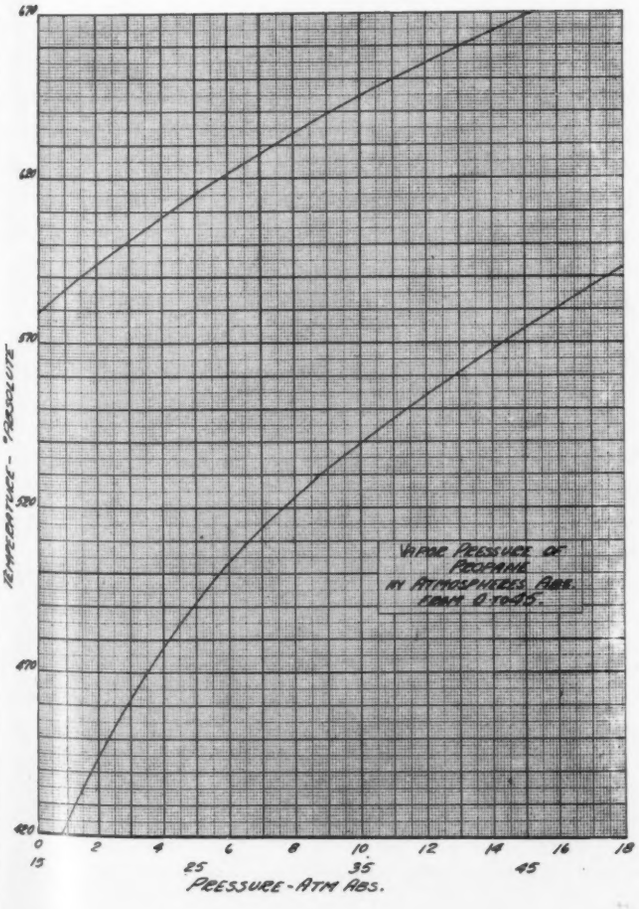
Formula=CH_4. Mol. Wt. 16.04
Melting Point=299.2°F. Boiling Point= —258.5°F.
Critical Temp. =115.8°F. Critical Pressure = 658.1 lb. sq. in. gauge.
Critical Density = 0.1615.

Vapor Pressure Data

Temperature		Vapor Pressure Absolute	Lb./sq. in. Gauge
°F.	°Abs.		
—297.7	162.3	1.35	—13.35
—295.7	164.3	1.82	—12.88
—288.4	171.6	2.94	—11.76
—281.1	178.9	3.68	—11.02
—258.7	201.3	14.70	0
—256.0	204.0	16.60	1.90
—238.0	222.0	34.53	19.83
—220.0	240.0	64.38	49.68
—202.0	258.0	103.40	88.70
—184.0	276.0	174.00	159.30
—166.0	294.0	262.00	247.30
—148.0	312.0	378.00	363.30
—130.0	340.0	528.00	513.30
—115.8	354.2	672.80	658.10

cal temperature of methane must be maintained on the overhead condenser if a methane reflux is to be obtained. (Note: The reflux to a column should be returned to the top plate and be of the same composition as the overhead product if possible.)

For commercial operation it is therefore impractical to make a clean cut separation of methane from the raw gasoline mixture as it would involve the use of too high pressures and too low temperatures to be practical. However, neither methane or ethane have any extended commercial use at present other than as fuel gas so the discussion for the time being will deal with means for their elimination through stabilization. Propane and isobutane are both of limited commercial use as "bottled gas." Their commercial use may be further extended both in the "bottled gas" industry and as raw material for chemical processing. The potentialities are good and therefore special consideration will be given to their separation by fractionation. At present there is not much attempt to recover the propane and isobutane in toto, as the potential supply of these materials is greatly in excess of the present markets. This being the case, the present practice is to recover only portions of these components while the remainder pass out with the fixed gases from the column to the fuel line to be used or sold as natural gas. The partial recovery simplifies the operating procedure and precludes the use of more expensive and extensive rectifying systems.



It will be noted in Table I that the critical temperature of methane is —115.8° F. and in Table II the critical temperature of ethane is 90° F. In order to separate methane by fractionation it would be necessary to maintain the temperature of the cooling medium below —115.8° F., which is obviously impractical from a commercial standpoint. The critical temperature of ethane is 90° F., so it would be possible to separate this constituent with a cooling medium around 60° F., using a column operating pressure of 550 pounds gauge. In

TABLE II
Ethane

Formula = $CH_3.CH_3$. **Mol. Wt. = 30.06**
Melting Point = —276.5°F. **Boiling Point = —127.5°F.**
Critical Temp. = 90°F. **Critical Pressure = 693.8 lb./sq. in. gauge.**
Critical Density = 0.220.

Vapor Pressure Data

Temperature		Vapor Pressure Absolute	Lb./sq. in. Gauge
°F.	°Abs.		
—220	240	0.27	—14.53
—202	258	0.76	—13.94
—184	276	1.83	—12.87
—166	294	3.92	—10.78
—148	312	7.62	— 7.10
—130	340	13.65	— 1.07
—112	358	22.90	+ 8.20
—103	367	29.02	14.32
— 99	376	36.36	21.66
— 76	394	55.02	40.32
— 58	412	80.44	65.74
— 40	430	112.70	98.00
— 22	448	154.40	139.70
— 4	456	206.00	191.30
+ 14	476	269.50	254.80
32	492	346.20	331.50
50	510	438.50	423.80
68	528	548.00	533.30
84	546	677.75	663.05
90	552	708.20	693.50

TABLE III
Propane

Formula = $CH_3.CH_2.CH_3$. **Mol. Wt. = 44.08**
Melting Point = —319.0°F. **Boiling Point = —48.1 °F.**
Critical Temp. = 204.1 °F. **Critical Pressure = 646.8 lb./sq. in. gauge.**
Critical Density = 0.210

Vapor Pressure Data

Temperature		Vapor Pressure Absolute	Lb./sq. in. Gauge
°F.	°Abs.		
—175.0	285.0	0.193	—14.504
—137.2	322.8	0.966	—13.731
—117.4	342.6	1.932	—12.675
— 94.0	366.0	3.864	—10.833
— 79.6	380.4	5.796	— 8.901
— 68.8	391.2	7.728	— 6.969
— 60.7	399.3	9.660	— 5.037
— 56.2	403.8	11.592	— 3.105
— 50.3	409.7	13.524	— 1.173
— 48.1	411.9	14.697	0
— 37.1	422.9	20.33	5.63
— 23.5	436.5	26.47	11.77
— 4.0	456.0	38.32	23.62
+ 32.0	492.0	73.54	58.84
+ 68.0	528.0	129.32	114.62
+122.0	582.0	285.50	270.80
+207.5	667.5	662.00	647.30

TABLE IV
Isobutane

Formula $(CH_3)_2.CH.CH_3$. Mol. Wt. = 58.077
Melting Point = —. Boiling Point = 11.3°F.
Critical Temp. = 272.7. Critical Pressure = 522.4 lb./sq. in. gauge.
Critical Density = —

Vapor Pressure Data

Temperature °F.	Temperature °Abs.	Vapor Pressure Absolute	Lb./sq. in. Gauge
— 22.0	438.0	8.96	— 5.74
— 13.0	447.0	10.54	— 4.16
— 4.0	456.0	12.50	— 2.20
+ 5.0	465.0	14.41	— 0.29
+ 11.3	471.3	14.70	0
86.0	546.0	54.00	39.30
140.0	600.0	135.50	120.80
194.0	654.0	249.80	235.10
248.0	708.0	420.00	405.30
272.7	732.7	537.30	522.60

TABLE V
N — Butane

Formula = $CH_3.CH_2.CH_2.CH_3$. Mol. Wt. = 58.077
Melting Point= Boilng Point=31.5°F.
Critical Temp. = 551.3°F. Critical Pressure = 303.4 lb./sq. in. gauge.
Critical Density = 0.22

Vapor Pressure Data

Temperature °F.	Temperature °Abs.	Vapor Pressure Absolute	Lb./sq. in. Gauge
0	460	7.3	— 7.4
5	465	8.2	— 6.5
10	470	9.2	— 5.5
20	480	11.6	— 3.1
30	490	14.4	— 0.3
31.5	491.5	14.7	— 0.0
35	495	16.0	+ 1.3
40	500	17.7	3.0
50	510	21.6	6.9
60	520	26.3	11.6
70	530	31.6	16.9
80	540	37.6	22.9
90	550	44.5	29.8
100	560	52.2	37.5
110	570	60.8	46.1
120	580	70.8	56.1
130	590	81.4	66.7
140	600	92.6	77.9
158	618	130.2	115.5
212	672	249.2	234.5
266	726	400.6	385.9
312	772	541.0	526.3

commercial practice, however, the methane, ethane and part of the propane and isobutane would be removed as the first overhead cut and the reflux would consist of principally ethane, propane and isobutane with some dissolved methane.

When operating on a raw stock it is more practical to make the stabilized natural gasoline first, and use the excess reflux in a second column for the production of gasoline. One reason for this is that the heavier materials such as pentanes, hexanes, etc., require too high temperature to maintain the column operating pressure such as is essential to the separation of methane and ethane. In plants where the raw stock is gathered in high pressure and low pressure accumulators, the liquid from the high pressure accumulator tank is frequently suitable for feed stock to a fractionating system producing "bottled gas."

MIXTURES SUITABLE FOR BOTTLED GAS

In Table IX the vapor pressures of various propane-isobutane mixtures are shown for temperatures from —20° F. to 110° F. In no case where the pressure is minus would gas flow from the cylinder. Assuming that the lowest winter temperature will not be lower than zero a mixture consisting of approximately 89 percent isobutane and 11 percent propane would be satisfactory. At 100° F. this mixture would have a vapor pressure of approximately 70 pounds gauge. A 50-50 mixture would be satisfactory under all conditions normally encountered. It should be held in mind, however, that as the gas vaporizes from the cylinder there is a refrigerating effect and also the liquid remaining in the cylinder becomes richer in isobutanes, so it is well to select a bottle gas mixture of higher vapor pressure such as, for illustration, 70 percent propane and 30 percent isobutane. In all cases an absolute analysis should be run on the fraction which is to be used as bottled gas. For some purposes a gas consisting substantially of propane would be most satisfactory. Isobutane, however, has a higher heat value per cubic foot, which for summer conditions makes an ideal fuel gas.

The most convenient source of raw stock for the

TABLE IX
Propane—Isobutane Mixtures

% Propane	% Isobutane	Calculated Vapor Pressures in lb. Sq. In. Gauge at Various Temperatures. —20°F.	—10°F.	0°F.	10°F.	20°F.	30°F.	40°F.	50°F.	60°F.	70°F.	80°F.	90°F.	100°F.	110°F.
0	100	—7.2	—5.4	—3.1	—0.1	+3.5	7.6	12.2	17.8	24.0	31.1	39.2	48.6	59.0	70.4
10	90	—5.4	—3.2	—0.4	+3.1	7.2	12.0	17.3	23.7	30.8	38.9	48.1	58.7	70.3	83.1
20	80	—3.6	—1.0	+2.2	6.2	11.0	16.4	22.4	21.7	37.7	46.7	57.0	68.7	81.7	95.8
30	70	—1.8	+1.2	4.8	9.2	14.8	20.9	27.5	35.7	44.6	54.5	65.9	78.6	93.2	108.6
40	60	0.0	+3.4	7.4	12.2	18.6	25.4	32.6	41.7	51.5	62.3	74.8	88.6	104.6	121.3
50	50	1.8	5.6	10.2	15.7	22.2	29.6	37.8	47.5	58.2	70.2	83.7	99.0	115.7	133.9
60	40	3.6	7.8	12.9	18.8	25.6	34.0	42.9	53.4	65.0	78.1	92.6	109.0	127.0	146.5
70	30	5.4	10.0	15.7	22.0	29.0	38.4	48.0	59.3	71.7	86.0	101.5	119.2	138.3	159.1
80	20	7.2	12.2	18.5	25.2	32.4	42.8	53.1	65.2	78.3	94.0	110.4	129.6	149.6	171.8
90	10	9.0	14.3	21.2	28.3	36.1	47.7	58.2	71.1	85.2	102.2	119.3	139.8	160.9	184.4
100	0	10.7	16.7	23.5	31.4	40.8	51.6	63.3	77.1	92.4	109.3	128.1	149.0	172.0	197.0

TABLE VI

Isopentane

(2 Methyl Butane)

Formula = $(CH_3)_2CH.CH_2.CH_3$ Mol. Wt. = 72.12
Melting Point = —
Boiling Point = 82.3°F.
Critical Temp. = 370°F.
Critical Pressure = 486.4 lb./sq. in. gauge.
Critical Density = 0.2343

Vapor Pressure Data

Temperature °F.	Temperature °Abs.	Vapor Pressure Absolute	Lb./sq. in. Gauge
— 26	434	0.97	—13.73
— 4	456	1.95	—12.75
+ 20	480	3.70	—11.00
30	490	4.78	— 9.92
40	500	6.04	— 8.66
50	510	7.59	— 7.11
60	520	9.34	— 5.37
70	530	11.68	— 3.02
82.3	542.3	14.70	0.00
86.0	546	15.95	+ 1.25
104.0	564	22.09	7.39
122.0	582	29.89	15.19
140.0	600	39.63	24.93
158	618	51.63	36.93
176	636	65.9	51.2
194	654	83.3	68.6
212	672	104.2	89.5
230	690	128.4	113.7
248	708	156.0	141.3
266	726	188.5	173.8
284	744	266.4	211.7
302	762	268.7	254.0
320	780	317.3	312.6
338	798	372.0	357.3
356	816	442.0	427.3
365	825	467.5	452.8
370	830	486.4	471.7

TABLE VII

Normal Pentane

Formula = $CH_3.CH_2.CH_2CH_2.CH_3$ Mol. Wt. = 72.12
Melting Point = —
Boiling Point = 97.3°F.
Critical Temp. = 387°F.
Critical Pressure = 488.5
Critical Density = 0.2323

Vapor Pressure Data

Temperature °F.	Temperature °Abs.	Vapor Pressure Absolute	Lb./sq. in. Gauge
— 15.0	445.0	0.97	—13.73
+ 8.2	468.2	1.95	—12.75
20	480	2.33	—12.37
30	490	3.11	—11.59
40	500	4.18	—10.52
50	510	5.33	— 9.37
60	520	6.81	— 7.89
70	530	8.46	— 6.24
80	540	10.52	— 4.18
90	550	12.65	— 2.05
97.3	557.3	14.70	0.00
104	564	16.88	+ 2.18
122	582	23.09	8.39
140	600	32.1	17.4
158	618	41.8	27.1
176	636	52.9	38.2
194	654	67.7	53.0
212	672	85.4	70.7
230	690	106.3	91.6
248	708	130.5	115.8
266	726	158.6	143.9
284	744	191.5	176.8
302	762	229.0	214.3
320	780	272.5	257.8
338	798	320.9	306.2
356	816	375.0	360.3
374	834	436.0	421.3
383	843	470.0	455.3
387	847	488.5	473.8

manufacture of "bottled gas" is from the reflux tank for the natural gasoline stabilizer. Absorption plants in general are better suited to the manufacture of bottle gas than are compression plants. The accumulator products from compression plants as a rule contain too much methane and ethane, as such systems are not sufficiently selective.

BUTANES

There is some commercial demand for the pentanes. There are three pentanes, namely, normal pentane, isopentane (2 methyl-butane) and neopentane. Neopentane has been found only in few gasolines, so the separation is normally between isopentane and pentane. The pentanes are separated with the butane fraction following natural gasoline stabilization. After the pentane has been separated all or part of the butane is again blended with the kettle product to increase the yield of gasoline. The fact that part of the pentane has been separated from the natural gasoline permits more butane to be blended with it so that the decrease in production is not in proportion to the pentane separated.

OPERATION FOR SPECIAL PRODUCTS

A brief outline of one practical procedure for the operation of a plant for the manufacture of special products would be as follows:

First there would be the high pressure stabilizer for the production of natural gasoline from the accumulator stock. The reflux condenser on this column should be operated as nearly totally condensing as possible. The excess reflux condensate would then be pumped to

TABLE VIII

Iso-Hexane (Disopropyl)

Formula=$C_3H_7.C_3H_7$ Mol. Wt.=86.15
Melting Point = —
Boiling Point=136.6°F.
Critical Temp. = 441.2°F.
Critical Pressure=439 lb./sq. in. gauge.
Critical Density = 0.2411

Vapor Pressure Data

Temperature °F.	Temperature °Abs.	Vapor Pressure Absolute	Lb./sq. in. Gauge
14	474	0.87	— 13.83
32	492	1.48	— 13.12
50	510	2.40	— 12.30
68	528	3.71	— 10.99
86	546	5.56	— 9.14
104	564	8.06	— 6.64
122	582	11.38	— 3.32
136.6	596.6	14.70	0.00
140	610	15.70	+ 1.00
158	628	21.27	6.57
176	646	28.10	13.40
194	664	36.58	21.88
212	682	46.60	31.90
230	690	58.9	44.2
248	708	73.4	58.7
266	726	90.5	75.8
284	744	110.4	95.7
302	762	133.2	118.5

TABLE X

Properties of Methane

Temp. °F.	Vapor Pressure Absol. Lb./Sq. In. P	Vapor Pressure Gauge G.P.	Specific Vol. Cu. Ft./Lb. Liquid V	Specific Vol. Cu. Ft./Lb. Vapor V	Density Lbs./Cu. Ft. Liquid 1/V	Density Lbs./Cu. Ft. Vapor 1/V	Heat Content above—280°F. Btu/Lb. Liquid h	Heat Content above—280°F. Btu/Lb. Vapor H	Latent Heat Btu per Lb. L	Entropy Btu Lb./°F. Liquid S	Entropy Btu Lb./°F. Vapor S	Temp. °Abs. 460/°F.	REMARKS
—297.7	1.35	—13.35	.....	.....	.....	.....	.....	.....	.....	.....	.....	162.3	Normal boiling point
—295.7	1.82	—12.88	.....	.....	.....	.....	.....	.....	.....	.....	.....	164.3	
—288.4	2.94	—11.76	.....	.....	.....	.....	.....	.....	.....	.....	.....	171.6	
—281.1	3.68	—11.02	.....	.....	.....	.....	7.4	228.3	220.9	.041	1.275	178.9	
—258.7	14.70	0	.0378	8.91	26.47	0.112	17.0	237.2	220.2	.085	1.176	201.3	
—256.0	16.60	1.90	.0380	8.02	26.31	0.125	18.9	238.5	219.7	.093	1.168	204.0	
—238.0	34.53	19.83	.0393	4.11	25.45	0.268	22.1	246.2	224.1	.099	1.109	222.0	
—220.0	64.38	49.68	.0409	2.36	24.45	0.424	50.5	253.2	202.7	.210	1.056	240.0	
—202.0	103.40	88.70	.0428	1.43	23.36	0.700	67.2	260.3	193.1	.260	1.007	258.0	
—184.0	174.0	159.30	.0452	0.916	22.13	1.093	84.0	265.7	181.7	.309	0.963	276.0	
—166.0	262.0	242.30	.0482	0.596	20.86	1.678	102.4	268.3	165.9	.351	0.913	294.0	
—148.0	378.0	363.30	.0526	0.388	19.03	2.578	123.0	268.5	145.5	.397	0.861	312.0	
—130.0	528.0	513.30	.0601	0.241	16.65	4.150	148.7	259.0	110.3	.451	0.785	330.0	
—115.8	672.8	658.10	.0993	0.0993	10.07	10.070	209.2	206.3	—02.9	.610	0.601	343.2	Critical Point

a second column under about 550 pounds pressure. There the bottled gas would be made by cutting out the light and heavy ends. The overhead vapors from this column would press into the fuel line with the exception of these used as reflux. The cooling and condensing of the reflux for this column could best be done by mechanical refrigeration.

The kettle product from the natural gasoline column would be passed to a third column operating at lower pressure where the butane and pentanes would be separated. The excess reflux condensate from this third column would then be sent to another column where the pentanes and butanes would be separated. All or part of the excess butane would then be returned and blended with the kettle product to make natural gasoline in accordance with predetermined specifications.

Lubricating Greases

(*Continued from page 183*)

jackets so constructed that the grease batch can be alternately heated or cooled, has been a big factor in obtaining uniformity of appearance. Recently substances formerly considered foreign to grease has been introduced to give them certain appealing characteristics. Latex solution is the chief culprit or benefactor as the case may be. The compound gives the lubricant a decided stringy unnatural grease texture.

As for the lubricating quality, the present assortment of greases has served remarkably well. For instance, we have stationary gasoline engines with main and connecting rod bearings lubricated with ordinary cup or pressure gun grease. The engine will operate at high speed for a day at a time without replenishment of lubricant. A shot of pressure gun grease in the shackle and king pin bearings of our motor cars and trucks will serve for a thousand miles or more. And a pack of fibrous sodium soap grease on the front wheel bearing will last for the life of the car. We have greases which will withstand temperature in excess of the flash point of the incorporated mineral oil. And on the other hand, we have greases which, at extremely low temperatures, offer only slightly more resistance to movement of a machine part than at normal temperatures.

Extreme pressure lubricants are not so well developed and cause us considerable worry. We are seldom sure that we are getting a properly compounded lubricant that under cold weather or heavy load conditions will safeguard against costly repairs.

It is in this field that we may expect a higher degree of perfection and a more widespread and definite knowledge of what the lubricant should be, but this knowledge must necessarily be preceded by more accurate and reliable testing methods and testing equipment. We need to know in definite and comparable units, the lubricating film strength of lubricants and their individual ingredients.

Regular Grade *Cracked Gasoline and "Q" Grade* Ethyl Compared

WILLIAM HUBNER[1] and GEORGE B. MURPHY[2]

WHILE the octane number method of rating gasoline quality has become generally recognized and accepted by the automobile and oil industries, doubts have been growing in the minds of many technologists as to the adequacy of this method as the only criterion on which to measure the value and base the price of motor fuel. Because of these doubts, road and laboratory dynamometer tests were made in which the performance of cracked gasoline from one refinery, undoped, was compared with that of "Q" grade gasoline of equal volatility and equal octane rating.

[1]Automotive Engineer, Universal Oil Products Company, Chicago, Illinois.

[2]Manager of the Research and Development Laboratories, Universal Oil Products Company, Chicago, Illinois.

The purpose of these tests was:

First, to determine whether or not there are important desirable qualities of motor fuel that are not disclosed by a consideration of octane rating only.

Second, if there are such characteristics to determine whether or not they belong in greater measure to cracked or to ethylized gasoline.

It was found by both the road and laboratory tests that there are desirable performance properties that are not shown by octane number tests, namely, miles per gallon and horsepower hours per gallon. In each

TABLE 1

Laboratory inspection data—regular-grade cracked and "Q" grade Ethyl gasoline

SAMPLE NO.	1	2
Description of Sample	Regular Grade Cracked	"Q" Grade Ethyl
Octane Number:		
(1) Motor Method	68	68
(2) Research Method	72	69
Reid Vapor Pressure, Lb./Sq. In.	7.5	8.0
Gravity, °A. P. I.	59.0	62.1
I. B. P. °F.	108	102
10%	149	147
20%	176	174
50%	241	244
90%	346	354
E. P. °F.	387	396

TABLE 3

Comparative consumption (m.p.g.) of test fuels at car speeds of 30 and 60 m.p.h.

	Consumption (m.p.g.) at Car Speeds of			
	30 m.p.h.		60 m.p.h.	
Test Car*	Cracked	"Q" Grade	Cracked	"Q" Grade
1	21.0	20.8	14.0	13.6
2	24.1	23.7	15.4	15.3
3	22.3	22.0	15.1	15.3
4	13.2	13.1	8.3	8.2
5	21.5	21.5	14.2	14.1
6	13.3	13.0	8.3	8.2
Average Miles per Gallon	19.2	19.0	12.6	12.5
Per Cent Increase in Mileage	1.1	....	0.8	....

*These are not in the same order as the cars listed in Table 2.

TABLE 2

Test car inspection and calibration data

MAKE OF CAR	Year	Model	Miles on Speedometer	Miles Since Carbon Removal and Valve Grinding	Corrected Speedometer Readings for Measured Mile and Car Speeds		
					Mile	30 m.p.h.	60 m.p.h.
Ford V-8	1932	Roadster	10,500	10,500	0.99	31	61
Ford V-8	1933	Coach	2,800	2,800	1.00	29	60
Chevrolet	1933	Coach	7,500	7,500	1.05	31	61
Plymouth	1933	Sedan	6,100	6,100	1.02	29	61
Packard*	1931	Coupe	24,500	10,500	0.99	31	61
Packard†	1931	Coupe	24,800	100	0.99	31	61

*Before carbon removal and valve grinding.
†After carbon removal and valve grinding.

of these the cracked product excelled the "Q" grade Ethyl gasoline.

Five test cars and two test fuels were used; inspection data for both are given in Tables 1 and 2.

The cracked gasoline used was a commercial non-ethylized regular-grade product of 68 octane number (motor method), which was marketed in the Chicago district during the summer of 1933.

The "Q" grade Ethyl gasoline of equal octane rating was prepared by adding tetraethyl lead (1.5 cc./gal.) to a blend of 95 percent straight-run and five percent cracked gasoline. The straight-run was obtained from the same refinery and from the same crude oil as the cracked product.

As noted from the Reid vapor pressure and Engler distillation in Table 1, the volatilities of the two fuels are substantially the same. The principal differences are in the gravity and chemical composition; these properties are important in that they determine the pounds of fuel and number of heat units per gallon.

Each test car was carefully conditioned by competent mechanics and ignition specialists. Carburetor and ignition settings received particular attention to make certain that they were strictly in accordance with factory specifications.

ROAD TESTS

The road tests were divided into six series. Each series consisted of acceleration and fuel consumption tests in one particular car. Days of approximately identical atmospheric conditions were selected. There was no attempt made to compare the results of one car with those of another.

All tests were conducted on a level stretch of road over a marked mile. At the start of each series of tests the car was driven until equilibrium conditions were reached. Two runs were made in each direction with each fuel and the results averaged. The corrected car speeds shown in Table 2 were used.

A specially designed fuel-measuring apparatus served for obtaining fuel-consumption data. It consisted essentially of a half gallon tank, a 500 cc. graduate and a three-way cock. To avoid evaporation losses the fuel was cooled before pouring it from the sample containers to the tank and graduate of the fuel-measuring apparatus.

With one exception each car was driven by its owner.

The same observer participated in all the tests. A record of the data obtained is given in Tables 3, 4 and 5.

TABLE 4

Acceleration characteristics of test fuels

Test Car*	Acceleration (in seconds) from 30 to 60 m.p.h.	
	Cracked	"Q" Grade
1	15.1	15.0
2	17.3	17.5
3	15.6	15.8
4	17.9	17.9
5	17.4	17.5
6	19.5	19.5
Average Acceleration (in sec.)	17.1	17.2
Per Cent Increase in Acceleration	0.6	.....

*These are not in the same order as the cars listed in Table 2.

TABLE 5

Effect of car speed on fuel consumption

Car Speed m. p. h.	Fuel Consumption m. p. g.
15	15.6
30	13.2
45	10.5
60	8.3

LABORATORY TESTS

The laboratory tests were made on a CFR dynamometer unit. This apparatus consists of a standard CFR variable-compression engine directly coupled to a General Electric candle-type dynamometer.

The CFR three-bowl carburetor (adjustable float bowl) was used. One float bowl was modified to receive fuel directly from a one-liter flash which rested on the fuel-weighing scales. Fuel consumption, the time required to consume 0.1 pound of fuel during a definite number of revolutions of the engine, was determined automatically by a special electrical hook-up of engine revolution counter, telechron clock, bell, and fuel-weighing scales.

Three series of tests were made under various conditions of knocking, carburetor setting, and mixture temperature. Each series required approximately seven hours of continuous engine operation.

In preparing the apparatus for the initial run, spark timing, valve tappet clearances, etc., were carefully set in accordance with CFR motor method specifications. These settings were left unchanged throughout the tests. Engine speed was kept constant at 900 r.p.m.; water jacket temperature at 212° F.; carburetor inlet air temperature at 100°F.; and crankcase oil temperature at 128-134°F. The only variables were mixture temperature, compression ratio, carburetor setting, and knock intensity.

At the start of each series of tests the engine was allowed to run for approximately three hours to insure equilibrium operating conditions. Four test runs were made with each fuel and the results averaged. A record of the data obtained is given in Tables 6, 7 and 8.

CONCLUSIONS

Under the conditions described above both the road and laboratory tests show that non-ethylized regular-grade cracked gasoline is a motor fuel superior to "Q" grade Ethyl of equal volatility and equal octane number rating (motor method):

(1) Road Tests:

At constant speeds of 30 and 60 m.p.h. (Table 3)

the cracked product gave an average increase of 0.8-1.1 percent. In 10 of the 12 comparative tests the cracked gasoline gave the better economy; in one equal economy resulted; and in the remaining test the "Q" grade Ethyl gave the better mileage.

In accelerating from 30 to 60 m.p.h. (Table 4) the average acceleration of the cracked product was 0.6 percent better than that of the "Q" grade Ethyl. In three of the six comparative tests the acceleration characteristics of the cracked gasoline were superior to those of the "Q" grade product; in two equal acceleration resulted; and in the remaining test the "Q" grade Ethyl gave the better performance.

(2) Laboratory Dynamometer Tests:

In all three series of tests (Tables 6, 7 and 8), made under various conditions of knocking, carburetor setting, and mixture temperature, the regular-grade cracked gasoline gave 1.6-1.7 percent more horsepower hours per gallon than the "Q" grade Ethyl product, i.e., 1.6-1.7 percent better fuel economy on a gallonage basis.

The power output as well as the fuel consumption on a weight basis is substantially the same for the two fuels. The principal reason for the superior economy of the cracked product is its chemical composition which gives it greater weight and greater number of heat units per gallon.

TABLE 6

Comparative performance of test fuels under incipient knocking conditions with carburetor set for maximum knock and maximum power

Test Fuel	Fuel-air Mixture Temp., °F.	Compression Ratio	Corrected* I.H.P.	Lb. Fuel per Hr.	Lb. Fuel per Gal.	Lb. Fuel per I.H.P. per Hr.	Indicated Thermal Eff., %	I.H.P. Hr. per Gal.	% Increase In I.H.P. Hr. per Gallon
MAXIMUM KNOCK									
(1) Cracked	300	4.9	3.33	1.59	6.184	0.48	27	12.93	1.6
(2) "Q" Grade	300	4.9	3.33	1.59	6.084	0.48	27	12.72	....
MAXIMUM POWER									
(1) Cracked	300	4.9	3.44	1.75	6.184	0.51	25	12.17	1.6
(2) "Q" Grade	300	4.9	3.44	1.75	6.084	0.51	25	11.98	....

*Corrected in accordance with Bureau of Standards recommended practice:

$$\text{Corrected I.H.P.} = (\text{B.H.P.} + \text{F.H.P.}) \frac{750}{\text{B-h}} \frac{+273}{288}$$

Where:

B = observed barometer pressure, m. m. Hg.
h = observed atmospheric water-vapor pressure, m. m. Hg.
t = observed temperature of carburetor inlet air, °C

TABLE 7

Comparative performance of test fuels under incipient and pronounced knocking conditions with carburetor set for maximum power

Test Fuel	Fuel-air Mixture Temp., °F.	Compression Ratio	Corrected I.H.P.	Lb. Fuel per Hr.	Lb. Fuel per Gal.	Lb. Fuel per I.H.P. per Hr.	Indicated Thermal Eff., %	I.H.P. Hr. per Gal.	% Increase In I.H.P. Hr. per Gallon
INCIPIENT KNOCK									
(1) Cracked	300	4.9	3.44	1.75	6.184	0.51	25	12.17	1.6
(2) "Q" Grade	300	4.9	3.44	1.75	6.084	0.51	25	11.98	....
PRONOUNCED KNOCK									
(1) Cracked	300	5.4	3.48	1.75	6.184	0.50	26	12.30	1.6
(2) "Q" Grade	300	5.4	3.48	1.75	6.084	0.50	26	12.19	....

TABLE 8

Comparative performance of test fuels at several fuel-air mixture temperatures under pronounced knocking conditions with carburetor set for maximum power

Test Fuel	Fuel-air Mixture Temp., °F.	Compression Ratio	Corrected I.H.P.	Lb. Fuel per Hr.	Lb. Fuel per Gal.	Lb. Fuel per I.H.P. per Hr.	Indicated Thermal Eff., %	I.H.P. Hr. per Gal.	% Increase In I.H.P. Hr. per Gallon
(1) Cracked	300	5.4	3.48	1.75	6.184	0.50	26	12.30	1.6
(2) "Q" Grade	300	5.4	3.48	1.75	6.084	0.50	26	12.19	....
(1) Cracked	200	5.7	3.85	1.86	6.184	0.48	27	12.80	1.7
(2) "Q" Grade	200	5.7	3.84	1.86	6.084	0.48	27	12.58	....
(1) Cracked	100	6.0	4.33	1.99	6.184	0.46	28	13.44	1.7
(2) "Q" Grade	100	6.0	4.32	1.99	6.084	0.46	28	13.21	....

Viscosity Change Comparison Chart

RICHARD GROSHOLZ
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THIS chart compares oils on the item of "body-holding" ability under temperature change, grading this ability by the viscosity indices of Dean and Davis (and Lapeyrouse)[1 5] The chart shows where an oil stands in relation to the new and tentative winter oil specifications of the Society of Automotive Engineers.[6] The chart also visualizes the range of viscosity characteristics of all oils coming under the various S. A. E. classifications. The method of ordinary use of the chart is first given, and further and special uses are described and exemplified, and the background of the chart is discussed. The chart employs Saybolt Universal viscosities.

Where the viscosity of an oil at 210°F. is between 37 seconds and 78 seconds, one finds a vertical line for the viscosity (at 210°) in the lower and middle part of the diagram; and if the viscosity is known at either 100° or at 130°F., a corresponding horizontal line can be found from the scales along either side. The intersections of the lines will fall: (a) in some relation to the nearly horizontal curves giving the "viscosity at 0°F.;" (b) inside one or another S. A. E. classification; (c) in some relation to one of the families of curves marked "Indices based on viscosities taken at 100°F., (and 210°F.)," or, "Indices based on viscosities taken at 130°F. (and 210°F.)."

For the higher viscosities at 210°, i. e., from 78 to 160 seconds, the upper system of vertical lines are used, and the same continuing system of horizontal lines, designated in value by the markings on the sides. Here viscosity index and S. A. E. classification alone are shown as zero viscosities are higher than the zero viscosity values which are of usual interest.

The Dean and Davis system of viscosity indices used here employs a scale of numbers from 0 to 100; there are oils which manifest an index below zero on this scale, and there are others which rate over 100; the viscosity index of the oil approximates either its origin, or its resemblance, by body holding ability, under temperature change, to oils of the origins shown in the following table, which is taken from the originating reference.[5]

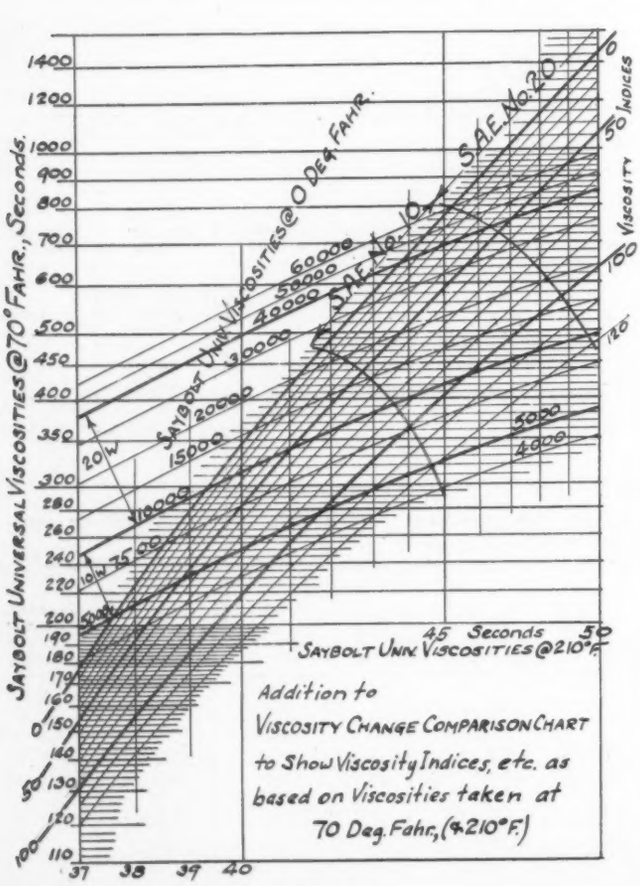


FIGURE 2

Source of Crude	Viscosity Index of Derived Lubricants
Pennsylvania "100% Paraffin"	100 or over
Mid-Continent	8
East Texas	6
Columbia	40
Peru	20
Gulf Coast "Napthenic"	0

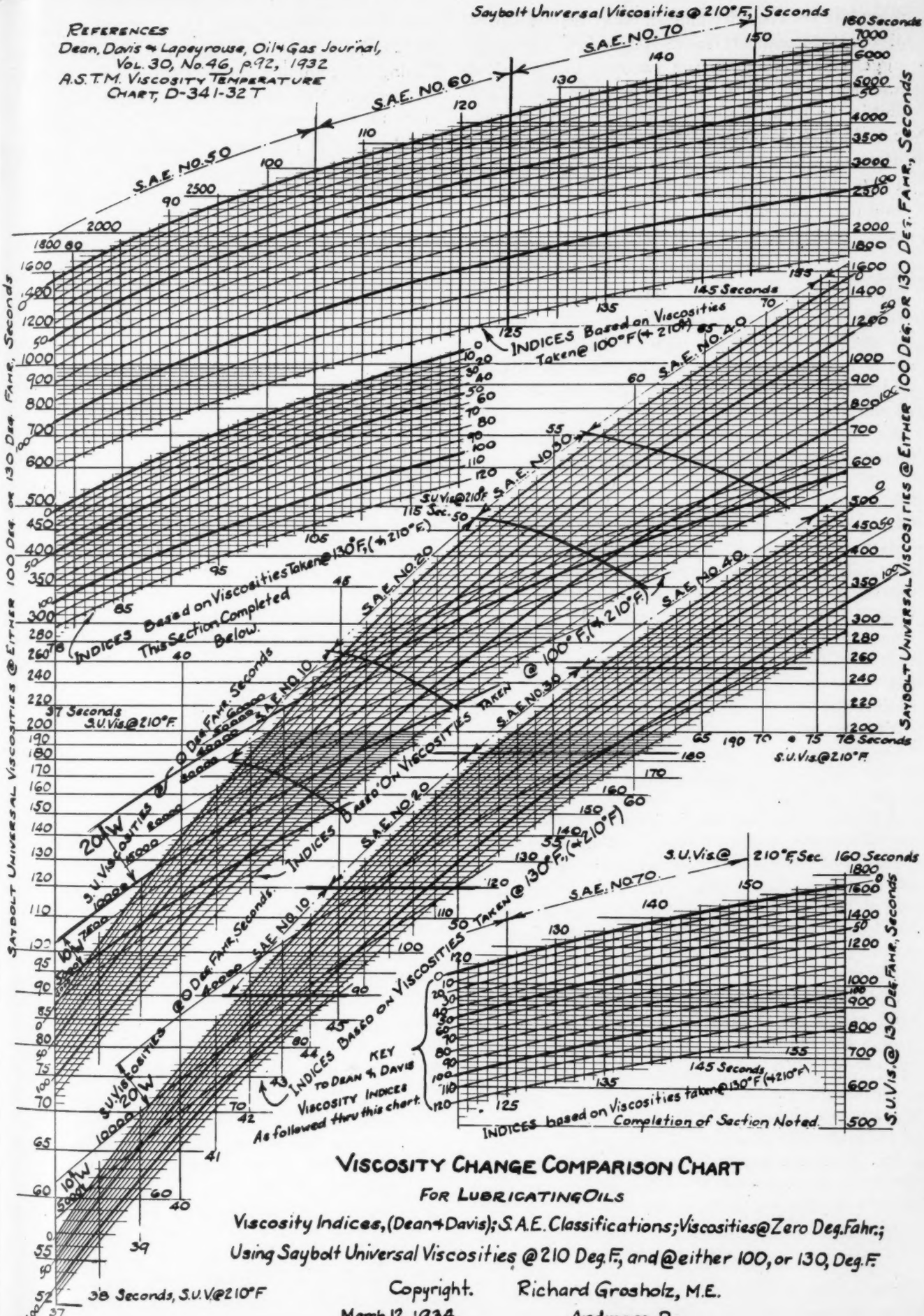
This chart can of course be worked forward or backward, going from one set of given conditions to required results, or in the opposite direction. A few examples of various uses of the chart are worked out in the next paragraphs.

EXAMPLE ONE

The S. A. E. Classifications 10 to 40 are remembered as stated in terms of viscosities at 130°F. Relations to these grades may be estimated by means of this chart from viscosities at 100 and 210°F. 58 seconds, viscosity at 210° and 680 seconds viscosity at 100°, for instance, located an oil within the S. A. E. 30 area.

EXAMPLE TWO

Throughout this discussion, tentative winter grades are classified by their viscosities at 0°F. Let


REFERENCES
Dean, Davis & Lapeyrouse, Oil & Gas Journal, Vol. 30, No. 46, p. 92, 1932
A.S.T.M. Viscosity Temperature Chart, D-341-32T
Saybolt Universal Viscosities @ 210° F., Seconds
S.A.E. NO. 70
S.A.E. NO. 60
S.A.E. NO. 50
S.A.E. NO. 40
S.A.E. NO. 30
S.A.E. NO. 20
S.A.E. NO. 10
INDICES Based on Viscosities Taken @ 100° F (+ 210°) 65 A.Q
INDICES Based on Viscosities Taken @ 130° F., (+ 210° F.)
This Section Completed Below.
INDICES BASED ON VISCOSITIES TAKEN @ 100° F., (+ 210° F.)
INDICES BASED ON VISCOSITIES TAKEN @ 130° F., (+ 210° F.)
KEY TO DEAN & DAVIS VISCOSITY INDICES As followed thru this chart.
INDICES based on Viscosities taken @ 130° F (+ 210° F.)
Completion of Section Noted
Saybolt Universal Viscosities @ Either 100 Deg. or 130 Deg. Fahr., Seconds
S.U. Vis. @ 210° F. Sec.
S.U. Vis. @ 130 Deg. Fahr., Seconds
0 Deg. Fahr. Seconds
20 W
10 W
145 Seconds
115 Sec.
37 Seconds S.U. Vis. @ 210° F.
38 Seconds, S.U.V. @ 210° F
190 TO 195 Seconds S.U. Vis. @ 210° F.

VISCOSITY CHANGE COMPARISON CHART

FOR LUBRICATING OILS

Viscosity Indices, (Dean & Davis); S.A.E. Classifications; Viscosities @ Zero Deg. Fahr.; Using Saybolt Universal Viscosities @ 210 Deg. F., and @ either 100, or 130, Deg. F.

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FIGURE 1

us explore the viscosity limitations at 100° of a 10-W oil of Mid-Continent base. A previous paragraph suggested 80 as an average viscosity index of Mid-Continent oils. The 80 curve crosses the lower 10-W limit in the 100-210° group at 119.5 seconds viscosity at 100°, and the upper limit of the 10-W zone at 164 seconds viscosity at 100°. Viscosity limitations at 210°F. of the same conditions are found at the same time; they are 40.4 and 43.3 seconds.

EXAMPLE THREE

It is evident by means of this chart that oils of a certain few viscosities at 100° will very probably always classify as 20-W, regardless of their source. An oil of zero viscosity index and 225 seconds viscosity at 100° lies just within the curve of 40,000 seconds viscosity at 0°; and an oil of 120 viscosity index and 220 seconds viscosity at 100° lies just above the curve of 10,000 seconds viscosity at 0°.

EXAMPLE FOUR

If the viscosities at 100° and 210° are known, it is readily possible to find the viscosity at 130°. Assuming 300 seconds viscosity at 100°, and 50 seconds viscosity at 210°, we find a viscosity index of 70 resulting. In the lower group of curves for use with viscosities taken at 130° and 210°, the 70 viscosity index line is seen to cross the 50 viscosity at 210° ordinate at 140 seconds, i. e., the corresponding viscosity at 130°.

EXAMPLE FIVE

A function of the chart is to compare the viscosities of oils at one temperature, which have the same viscosity at another temperature. Let us first find the extreme viscosities at 210° likely to be exhibited by oils of 700 seconds viscosity at 130°. In the upper family of 130-210° curves, the horizontal line representing 700 seconds meets the zero viscosity index curve at 94.5 seconds viscosity at 210°; and in the completion of this group of curves in the lower right hand corner of the sheet, the 700 viscosity line crosses the 120 viscosity index line at 142.5 seconds viscosity at 210°.

Then compare the viscosities at 100° of an oil of 94.5 seconds viscosity at 210, and zero, and of an oil of 142.5 seconds viscosity at 210° and 120 viscosity index. From the proper inter sections at the top of the chart, the respective viscosities at 100° are noted as 2330 seconds and 1500 seconds.

EXAMPLE SIX

It is readily possible to obtain viscosity index and corresponding viscosity at 210°, where viscosities at 100° and at 130° are given. Let us assume viscosities of 110 seconds at 130°, and 220 seconds at 100°. Taking the edge of a sheet of paper, lay it along the 110 seconds line through the 130-210° family, and mark all the crossing points of the viscosity index lines; and also mark the crossing point of one of the coinciding 210° verticals, and numbering it. Then lay the edge of the paper along the 220 second line through the 100-210° group, with the marked vertical ordinate giving the side-wise position, which means to move the paper straight up. It will be noticed that the 70 and 80 viscosity index lines from the lower group will lie between the 70 and 80 viscosity index lines of the upper family, and that the viscosity indexes of 75 may be estimated as corresponding. This agreement will occur at a viscosity of about 46.2 seconds at 210°. This may be conveniently verified on the A. S. T. M. chart, as regards the viscosity at 210°.

The system used in this chart of classifing oils in accordance with the resistance of the oils to temperature-viscosity change was described by E. W. Dean and G. H. B. Davis[1] in 1929, and revised by them and M. Lapeyrouse in 1932.[5] The originators plotted the results of the viscosity determinations of many typical paraffin base oils of different viscosities, forming a curve, from which the "100" curves of the 100-210° groups in Figure 1 are the eventual off-spring. The series of oils thus described, comprising oils having the highest resistance to temperature-viscosity change, was called the "H" series. Typical naphthene oils were measured and plotted, giving the data for the "L" series. The oils of the "L" series have the contrasting lower resistance to temperature-viscosity change, and are located in Figure 1 as the "O" curves in the same families of lines. In the original references, the constituents of the H and L series were listed in tabular form, giving the corresponding viscosities at 100° for each possible viscosity at 210° of a typical oil of high resistance to temperature-viscosity change, and of a typical oil of low resistance to temperature-viscosity change. Thus, when the viscosities of any oil are known at 100° and at 210°, the resistance which the oil possesses to temperature-viscosity change may be compared by a simple arithmetical proportion with the resistance to temperature-viscosity change of a typical paraffin base oil of the same viscosity at 210°.

Discussions of viscosity index[4,5] stressed the desirability of low temperature viscosity changes in oils on account of the related comparatively lower viscosities at low temperatures. Actual designation of winter oils by their viscosities at 0°F. will be recalled as having been announced within the year.[6] The viscosities of 10-W and 20-W tentative grades of winter oils are obviously not readily obtained at 0°F. The directions of the Society of Automotive

Engineers indicate that the viscosity at 0°F. shall be found by plotting the experimentally determined viscosities at 100° and 210°F. on the A. S. T. M. Viscosity Temperature Chart, D-341-32T, and extrapolating the same to 0°F.

Three groups of curves of viscosities at 0°F. were found by means of the A. S. T. M. chart, and appear in Figures 1 and 2. The finding and the application of the 40,000 seconds viscosity curve in each of the three groups may be considered as an example. One end of a straight edge is held fixed at 40,000 seconds viscosity at 0°F. on the A. S. T. M. chart, and the other end is moved second by second up the 210°F. line. At each second, the viscosities are read at the intersections of the straight edge with the 70 and 100 and 130°F. lines, and are plotted on the vertical ordinates on Figures 1 and 2 which correspond to the viscosity at 210°F. at which the lower end of the straight edge is being held on the A. S. T. M. chart. The curves thus mark various combinations of viscosities at 210° and either 70, or 100, or 130°. An oil which shall have a viscosity of 40,000 seconds at 0°F. must have one of these combinations of viscosities. Let us consider the implications of these curves.

We will assume 44 seconds and 230 seconds as the respective viscosities of an oil at 210° and at 100°. The intersections of the proper lines occur on the 40,000 seconds viscosity curve, in Figure 1, and also on the 10 viscosity index curve. If the oil's viscosity at 100° had been taken as 240 seconds, it must have had a viscosity of 44.7 seconds to remain inside the 40,000 seconds viscosity curve, and would have thus exhibited a viscosity index of 20. Recalling the A. S. T. M. chart, it is evident that as we hold one end of the straight edge constant at 40,000 seconds viscosity at 0°F., if we increase on viscosity slightly, we raise all the viscosities for all temperatures above 0°F.

This example both verifies the mechanics of the 0°F. viscosity curves and emphasizes the fact that if one wants a winter oil with increased viscosities at higher temperature, one must use either a better prepared oil or an oil from a crude whose derivatives naturally tend to manifest higher viscosity indices.

These curves of viscosities at °F. are given for the convenience that they may offer in allowing the rapid estimation of an oil's relation to the winter oil specifications. The letter of definition calls for the use of the A. S. T. M. chart in labelling an oil as 10-W or 20-W. It is believed that the chart given here will be found accurate in this feature, but it has no official recognition.

It is necessary to consider the limits of accuracy of the viscosity index system as expressed in this chart. The originators[1 5] referred to the inordinate accuracy of a series of 100 divisions as applied to the oils of the lower viscosities. In the tabulation below, the accuracy of the viscosimeter, and the size of the unit of viscosity index are compared at intervals over the range of the chart.

Viscosity at 210 Deg.	1% Viscosimeter Reading at 100 Deg. F. Oils of 100 V.I.	Oils of 0 V.I.	Value of 1 Unit of V.I.
160	26	67	42
120	16	38	22
80	8	16	8
50	3	4	2
45	2	3	1
40	1.1	1.3	.3
37	.7	.9	.2

One unit of viscosity index is covered in all cases by one tenth of the distance between adjacent viscosity index curves. This table shows that in the cases of viscosity indices near zero viscosity index, one unit of viscosity index is always less than the generally accepted accuracy of the viscosimeter. For the higher viscosity indices, in the upper ranges of the chart, estimated divisions of the space between viscosities index curves have some value; but throughout the lower ranges of viscosities, too much stress must not be placed upon the fact that one oil exceeds another slightly in viscosity index. At the lower viscosity levels, the lower viscosity reading may cause an inaccuracy of viscosity index of some three estimated units; but the inaccuracy of the viscosity determination at 210° makes a maximum variation of 40 units possible in viscosity index, at the lowest part of the scale, for the higher viscosity indices in that neighborhood.

It is believed that the chart can rate all oils accurately for 0°F. viscosities, but the viscosity indices cannot determine the sources of oils of the lighter viscosities with finality. The refining process may make the source of a light oil less recognizable; the refining process may make it unnecessary to recognize the source of a light oil, as what the oil can do may be of more importance than where the oil came from.

Another limitation of the usefulness of viscosity index in the lower ranges, that is, below 50 seconds viscosity at 210°, is the possible lack of finality of the list of Series H and L oils at those viscosities. Due largely to having secured more accurate viscosities, the originators revised their first lists in the lower ranges.[5] The viscosities on this chart below 40 seconds viscosity at 210° are extrapolations, and have not appeared in the work of Dean and Davis. The H and L series of oils are a tabulation of the average experiences of the authors of viscosity index; these series are not absolute quantities in the sense that one single physical measurement is absolute.

The unrevised series of H and L oils has been announced as substantially checked by Larson and

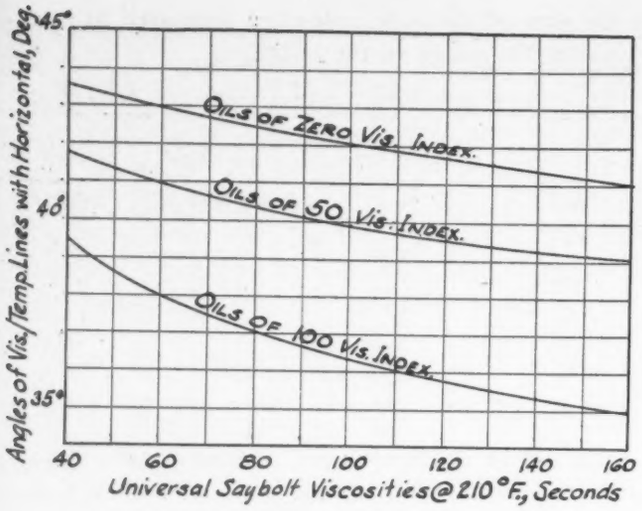

FIGURE 3

Schwaderer,[4] and these series were adopted by them in their entirety as the bases of a chart similar in some respects to Figure 1. These authors divided the space between the H and L series by a system of seven "zones" which were laid out to give consideration to the varying accuracy of the viscosimeter of the range of viscosities as dwelt upon above. They stressed the limitations of a system of viscosity indices and did not present the lower parts of the scale in a fashion that would lead to undue anticipation of value in close use of viscosity index at these points.

The spreading out of the lower 210° viscosity ordinates permits the graphical treatment of the winter oils, and emphasizes the position of the middle classifications. Regarding the numbering of the divisions, it is suggested that a decimal system is generally to be preferred, on account of its flexibility. This Dean and Davis system of classification is frequently referred to in lubrication literature. The originators gave several instances themselves in the second reference,[5] though the writings that they referred to were those of their associates. The papers delivered before the Pennsylvania Grade Crude Oil Association at Pennsylvania State College last June, however, contained frequent instances of the use of Dean and Davis indices, and usually under the simple designation of "viscosity index."

There is a sub-committee of Committee D-2 of the American Society for Testing Materials charged with selecting a standard system of viscosity index. They have some 10 systems before them for consideration. A. Ludlow Clayden has proposed an index system on an absolute basis[7] which employs certain standard lines drawn on the A. S. T. M. chart mentioned. These lines originate at the intersection of 0°C. and 10,000 centistokes and are drawn to the intersections of 100°C. and the viscosity lines in centistokes from 9 up to 40. They are recognized by the number of the centistoke at the intersection, or by the angle which the connecting line made with the horizontal. Thus the plot of any oil on the A. S. T. M. chart may be graded by a protractor. It is evident that temperature-viscosity coefficients of oils measured with different types of viscosimeters can be readily compared, in conjunction with proper charts, by the use of lines drawn with the help of the centistoke divisions. This type of line will not readily distinguish between classes of oils, however; the slopes of the various oils of the H series vary throughout the list, as do those of the L series. This variation in slope of oils of the same viscosity index when drawn on the A. S. T. M. Viscosity Temperature Chart is shown in Figure 3.

Typical corresponding series of H and L viscosities have been prepared for viscosities at 130°, as evidenced by various graphical work.[3 4 5] Such series are readily obtained by alignment on the A. S. T. M. chart. In preparing the series of typical viscosities at 130° for this chart, the values were found by using the straight line formula of Messrs. Sloane and Winning[2], viz:

$$\text{Log}_{10}\ \text{Kinematic Viscosity} = \frac{C}{(\text{Temp.} + B)} + A$$

in which equation A, B, and C are constants for each oil; the authors discuss efforts to simplify the equation by finding a universally applicable value for B. In preparing these series of typical oils at 130°, lists in proper progression and close agreement between chart and formula were found by using 145 for the value of B in the case of the paraffin oils and by using 100 for the value of B in the case of the series of napthene oils.

Thanks are due to Dr. J. C. Geneisse of The Atlantic Refining Company, for assistance in verification of certain of the information contained in this chart; to R. B. Krauss, of Purol, Inc., for certain technical suggestions and to Dr. Harold M. Lufkin, of the Department of Mathematics of the University of Pennsylvania, for suggestions in the preparation of the chart.

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[7]A. Ludlow Clayden, National Petroleum News, Oct. 18, 1933.

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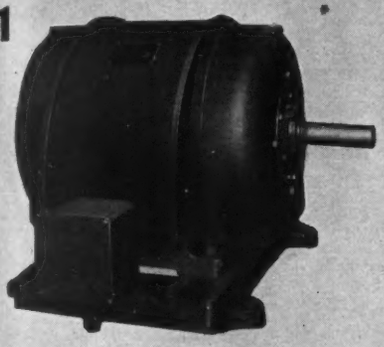

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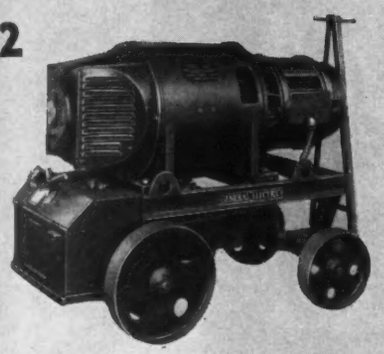

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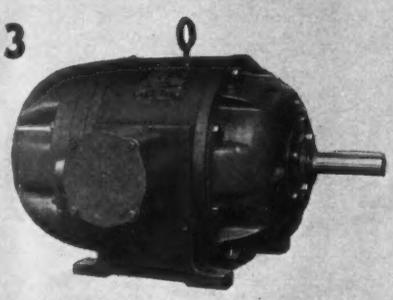

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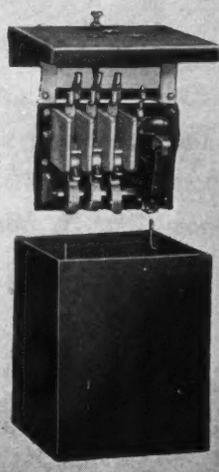

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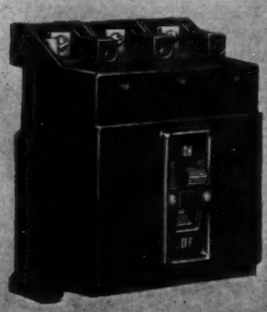

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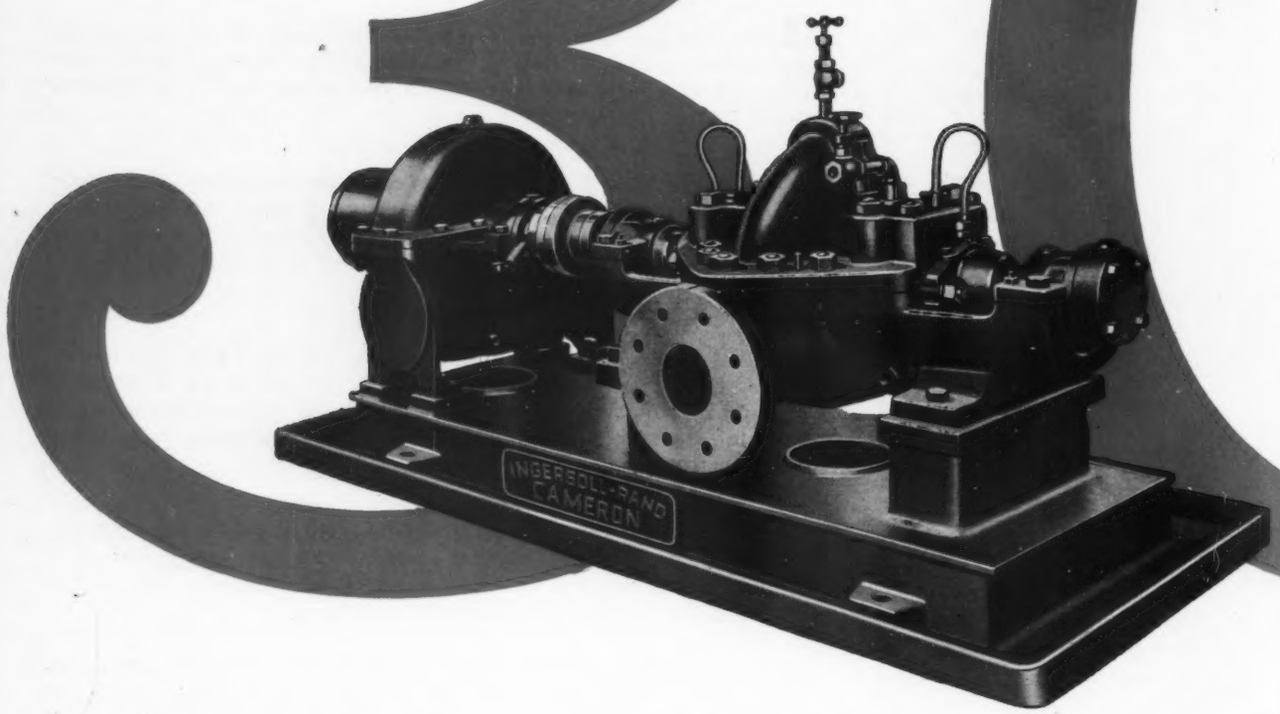

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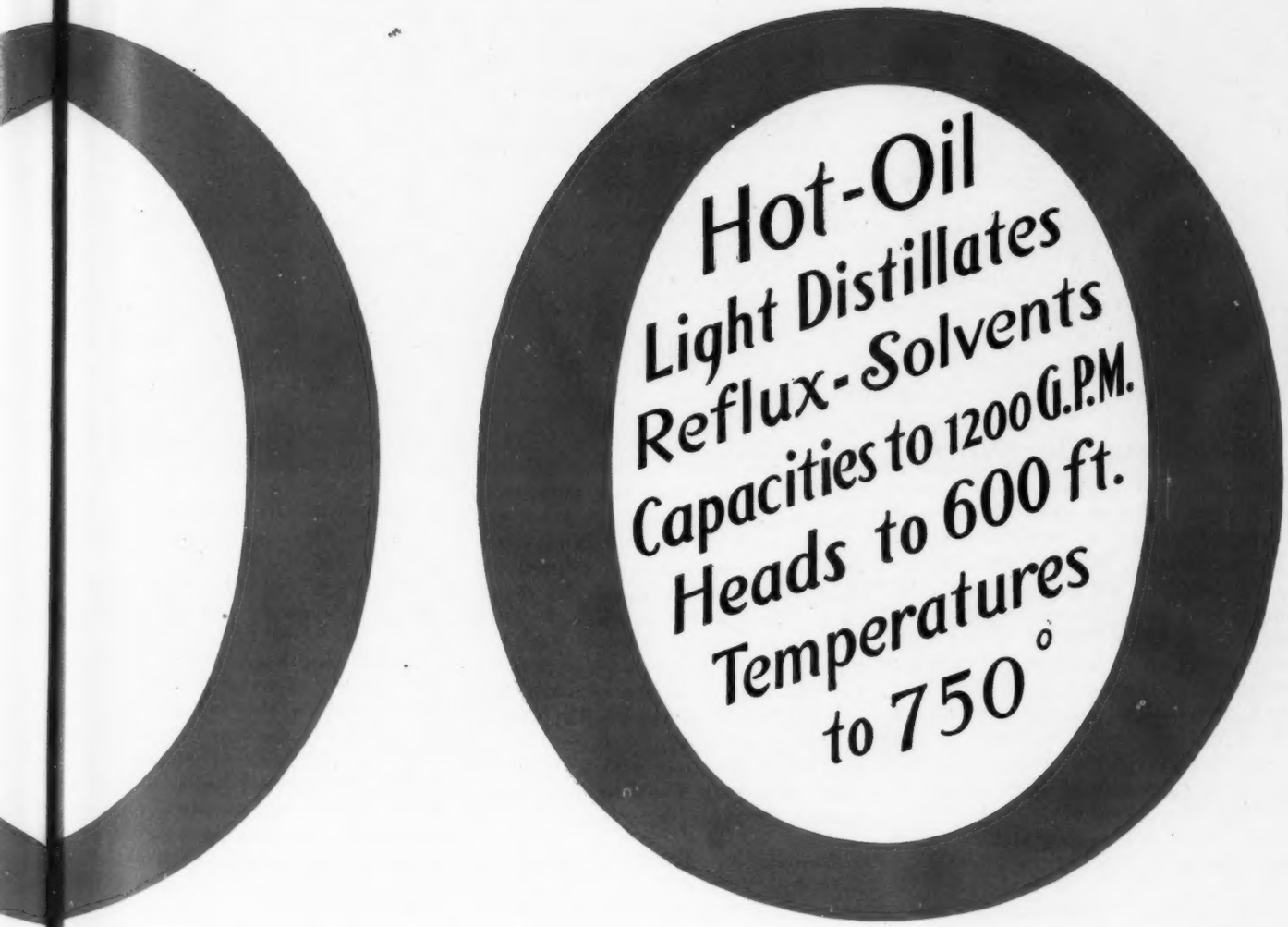

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Photostat copies of original articles will be supplied at cost by the Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstract, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

Fundamental Physical Data

Density of Propylene in the Liquid and Vapor Phases near the Critical Temperature. C. A. WINKLER and O. MAASS. *Canad. J. Res.* **9** (1933) p. 610.

The density of propylene in the liquid and vapor phases over the temperature range 66° to 92° C. has been measured by a refined dilatometer method and by a float method. The two methods gave good agreement, the float method being preferred in the neighborhood of the critical temperature. At temperatures lower than the critical it was found that the vapor density did not vary with changes in the relative volume of the liquid.

Density Discontinuities at the Critical Temperature. C. A. WINKLER and O. MAASS. *Can. J. Research* **9** (1933) pp. 613-29.

A technique for measuring densities at various points in a one- or two-component system at a temperature above the critical is described. Propylene and methyl ether were the substances studied. When either liquid was heated above the temperature at which the visible meniscus disappeared the density below this point was greater than that above. The density was uniform throughout each portion but changed sharply in the small region where the meniscus was last observed. After one hour at constant temperature the difference in density between top and bottom became constant and remained so for six hours. The density difference observed for a fixed available space decreases with temperature rise and is measurable up to a temperature 10° above the critical.

Formula for Specific Volumes of Saturated Vapors. C. H. MEYERS. *Bur. Standards J. Res.* **11** (1933) pp. 691-701 (Research Paper No. 616).

A formula is given to express specific volume of a vapor in terms of the vapor pressure, the specific volume of the liquid, and two empirical constants. Over the pressure range up to one-fourth of the critical pressure the formula was found to represent the data for twenty-three substances within experimental error.

Viscosity and Its Expression. E. C. BINGHAM. *Proc. World Petr. Congr.* **2** (1933) p. 512.

The use of the unit, the Centipoise, has given absolute viscosities a name and at the same time rendered them "specific." A primary standard, such as the viscosity of water at 20°C., should be adopted as this will increase the precision of viscosity measurement. The U. S. Bureau of Standards has started an exhaustive study of the viscosity of water. Definitions are presented for consistency, viscosity, plasticity, and elasticity, as well as definitions of a simple liquid, a non-Newtonian liquid, and a solid.

Physical Factors Governing Cracking Operations. G. G. BROWN, W. K. LEWIS and H. C. WEBER. *Ind. Eng. Chem.* **26** (1934) pp. 325-29.

The information available on the pressure - volume - temperature relation of hydrocarbons is reviewed. Methods based on these relationships are indicated for calculating important thermal properties of hydrocarbons and hydrocarbon mixtures. Methods of computation for evaluating the conditions existing at equilibrium in vapor-liquid mixtures are also given. Methods of extrapolating from known data and quantities computed therefrom and their application in the solution of cracking plant problems are discussed.

Chemical Composition and Reactions

Application of Raman Spectra to the Identification of Hydrocarbons in Gasolines. A. ANDANT. *Chim et Ind.* **29** (1933) Spec. No. 480-491.

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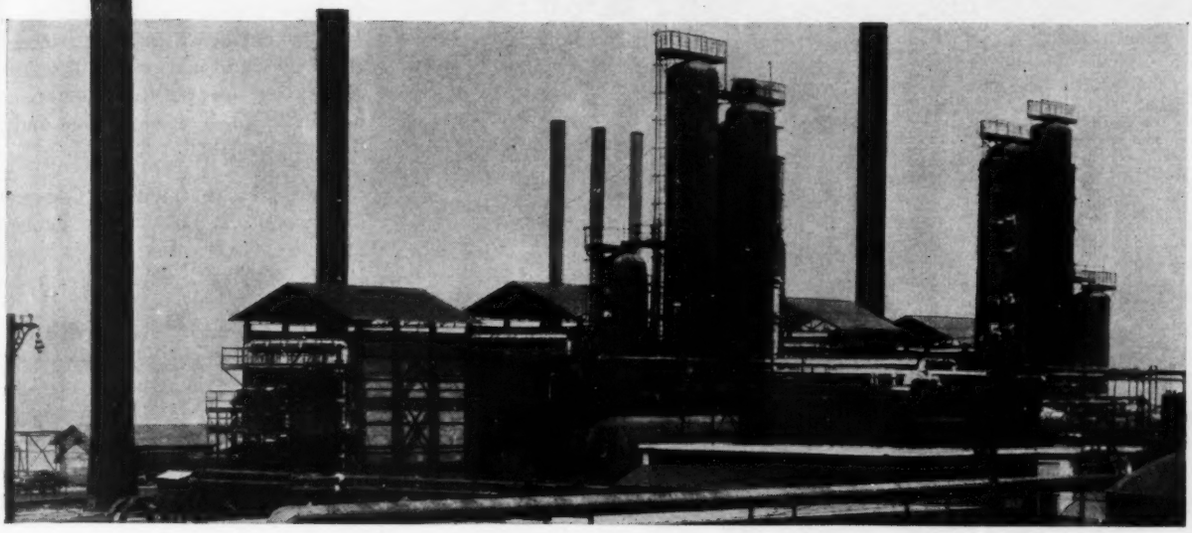

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analysis of gasoline is proposed. The method does not permit identification of all hydrocarbons present in a gasoline because of similarity of the spectra of hydrocarbons of the same group. It does lead to a precise knowledge of the chemical groups present and then by examination of the infra-red absorption spectra the components can be identified. The apparatus and method are described.

Thermal Treatment of Gaseous Hydrocarbons. I. Laboratory Scale Operation. A. E. DUNTON, E. N. HAGUE and R. V. WHEELER. *Ind. and Eng. Chem.* **26** (1934) pp. 307-14.

The thermal decomposition and polymerization of the gaseous hydrocarbons is reviewed. Conversion to a blending stock of 392°F. end point of 16 to 25% when using paraffins, and 25 to 30% when using olefins is readily obtained at atmospheric pressure and at temperatures of 750 to 950° C. This blending gasoline contains benzene, toluene, styrene, meta and para xylene, and indene. The higher boiling liquid product contains naphthalene, anthracene, phenanthrene, and chrysene. By polymerizing olefins at pressures between 200 and 2000 pounds per square inch and at temperatures of 300 to 550°C conversions into liquids up to 92% are obtained. Of the liquids so made 86% is of gasoline boiling range and about five-sixths has the blending efficiency of benzene. The gasoline fraction contains olefins and paraffins with three to eight carbon atoms to the molecule.

The Destructive Hydrogenation of Phenyl-Octadecane. K. LAIDLER and A. SAAYNA. *Jour. Inst. Pet. Tech.* **20** (1934) pp. 162-67.

In destructive hydrogenation the order of thermal stability of several hydrocarbons is benzene, toluene, phenyl-octadecane, and octadecane, the last being the least stable. In the phenyl-octadecane molecule the benzene ring is far more stable than the paraffinic side-chain. At 440°C. phenyl-octadecane splits off the side-chains entirely or partly, yielding a small amount of gas and liquid composed of benzene and its homologs and paraffinic hydrocarbons. The rate of hydrogenation of the aromatic nucleus increases only from 470°C. up. At 490°C. two-thirds of the phenyl-octadecane appears in the form of gaseous molecules, the resulting liquid being largely aromatic.

Spontaneous Ignition Temperatures of Hydrocarbon Mixtures. S. COFFEY and T. BIRCHALL. *Chem. & Ind.* **53** (1934) pp. 245-47.

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The formation of gum in gasoline in contact with the atmosphere ordinarily takes place very slowly for a considerable period and then increases rapidly. If the period between refining and consuming is greater than this period of slow gum formation, the use of Wiggins Pontoon Roofs on gasoline storage tanks is clearly beneficial.

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Operation	Ordinary Storage	Wiggins Roof
Filling refinery storage..	0.1	0.0
Refinery storage (4 mo.)	1.0	0.15
Filling barge	0.1	0.1
Filling bulk storage....	0.1	0.0
Bulk storage (2 mo.)..	0.5	0.05
Filling tank truck.....	0.3	0.3
Filling tank at station..	0.3	0.3
Filling tank on truck..	0.3	0.3
TOTAL	2.7	1.2

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ignition apparatus it was found that for standard gasolines there were two spontaneous ignition zones. Ignition would take place in the range of temperature from 320° to 335°C. There would then be a zone of non-inflammability from 335° to 420°C. and from 420° up ignition occurred at all temperatures. The addition of anti-knock substances in increasing quantity gradually narrowed the lower ignition zone until it finally disappeared. The addition of a knock inducer extended the temperature range of the lower ignition zone. Very small quantities of lead tetraethyl entirely repressed spontaneous ignition in the lower zone.

Direct Oxidation of Saturated Hydrocarbons at High Pressures. P. J. WIEZEVICH and P. K. FROLICH. *Ind. & Eng. Chem.* **26** (1934) pp. 267-76.

The oxidation of methane, ethane, propane, butane, pentane, and heptane derived from natural gasoline has been studied. Use was made of high pressure and relatively low temperature. The product had been separated by fractionation. The work was carried on both in the laboratory and at a semi-commercial plant at Breckenridge, Texas. Alcohol, aldehyde, acid, and ketone were among the reaction products. The higher hydrocarbons undergo a carbon-carbon scission during oxidation with the formation of lower derivatives in high yield. If organic acids are desired as the main product, recirculation of the intermediate compounds may be used as a means of securing acid as the end product. The article contains many data, diagrams, and photographs, as well as a clear exposition on the whole subject and a discussion of previous work.

Manufacture: Processes and Plant

Chemical Engineers' Handbook. J. H. PERRY, Editor. *Book, McGraw Hill Company,* 1934.

Besides the usual handbook data on weights and measures, mathematics, and physics the Chemical Engineers' Handbook includes treatment on physical and chemical principles, the flow of fluids, heat transmission, evaporation, humidification, de-humidification, cooling towers, gas absorption, adsorption, distillation, drying, mixing, mechanical separation, crushing, grinding and pulverizing, control of process variables, materials of construction, high pressure technique, material handling, fuels, power generation and transmission, refrigeration, electro-chemistry, economic factors in plant location, accounting and cost finding,

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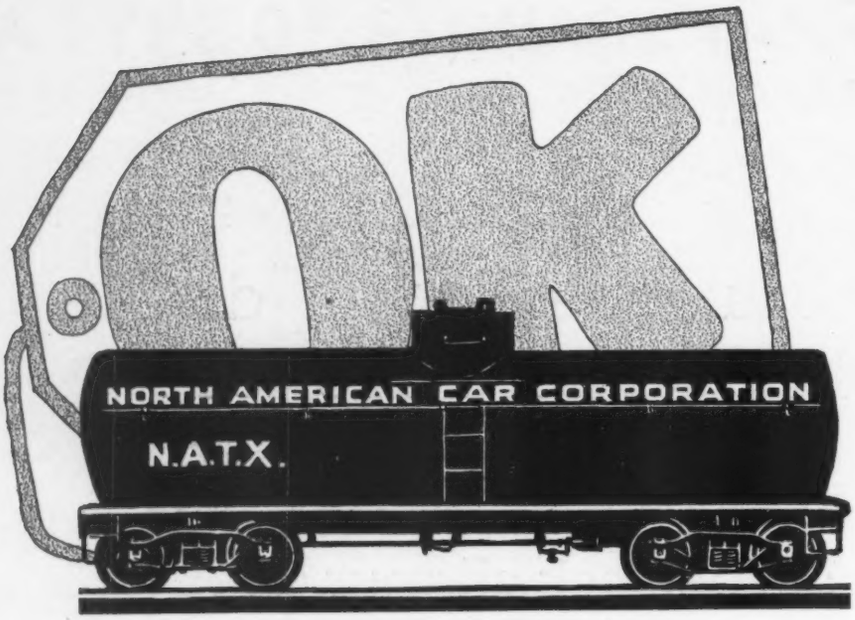

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safety and fire protection, report and report writing, patents and patent law. It is well prepared and should be an invaluable reference work for any one dealing with processing procedures.

Petroleum Industry, Maker and User of Chemicals. A. L. DAVIS. *Chem. & Met. Eng.* **41** (1934) pp. 136-39.

The author reviews the petroleum industry as a producer and as a consumer of chemical products. Ethylene at present is the most important chemical raw material derived from petroleum. However, other materials such as propane, propylene, pentane, paraffin wax, and some of the higher boiling oils are becoming of increasing importance. On the other hand, the industry consumes reagents for chemical treatment, gum inhibitors, antioxidants, anti-knock compounds, numerous special solvents, and various other special chemical materials. These are briefly discussed and listed in large numbers.

Gaskets for Pressure Vessels and Heat Exchangers. C. O. SANDSTROM. *Chem. & Met. Eng.* **41** (1934) pp. 130-34.

Different types of gaskets and gasketed and ground joints are discussed. The stresses in gaskets are analyzed. Thin gaskets are considered versus thick gaskets, and wide versus narrow gaskets. Temperature stretch of bolts and the manner of tightening bolts are discussed.

The Calculation of the Mean Temperature Difference in Multi-Pass Heat Exchangers. A. J. V. UNDERWOOD. *Jour. Inst. Pet. Tech.* **20** (1934) pp. 145-58.

For single pass heat exchangers the mean temperature difference is given by the logarithmic mean. The derivation of the formula for the logarithmic mean is based on the assumption (1) the coefficient of heat transfer does not vary, (2) the specific heat of each fluid is constant, (3) the mixing of each fluid is sufficient to insure uniform temperature over any cross section. Based on these same assumptions, the mean temperature difference in multi-pass heat exchangers is not given by the logarithmic mean formula. Equations are derived whereby the mean temperature difference is expressed in terms of the inlet and outlet temperatures of the two fluids. Several combinations of passes are considered.

Thermal Treatment of Gaseous Hydrocarbons. II. Semi-Industrial Production of Aromatic Hydrocarbons from Natural Gas in Persia. W. H. CADMAN. *Ind. Eng. Chem.* **26** (1934) pp. 315-20.

The work described deals with the thermal treatment of natural gas on a

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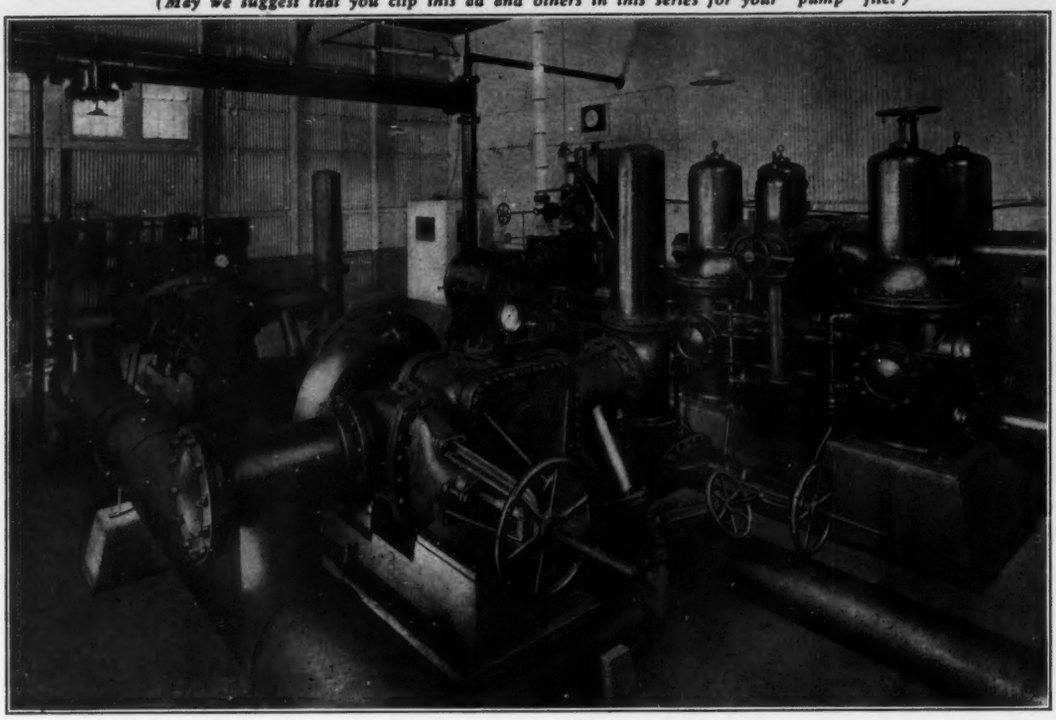

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14	16	224
13	1	13
12	3	36
11	35	385
10	5	50
9	12	108
8	13	104
7	10	70
6	3	18
5	17	85
4	6	24
3	3	9
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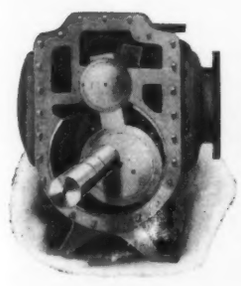

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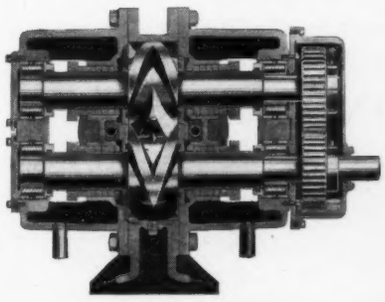

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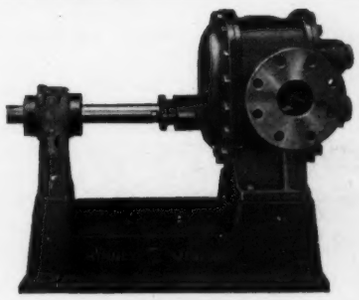

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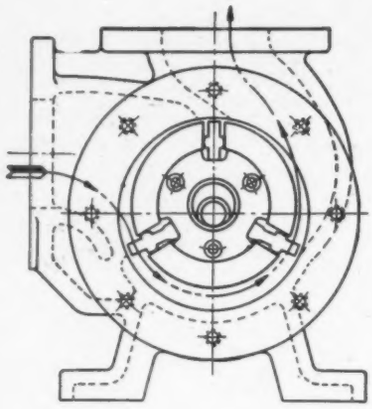

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semi-commercial scale in the oil fields of Persia. These gases contain from four to twelve per cent of sulphur as H_2S. The methods of de-sulphurization used are described. The yields of benzene from the thermal treatment of the gaseous materials under varying conditions of temperature and pressure were found and optimum conditions determined. Special heat resisting alloy steel tubes in a radiant heat type of furnace were found to be best, but the ideal metal for the tubes of a thermal treatment plant has not yet been found. Material used is important because of its catalytic action on the gases that influences both benzene formation and carbon deposition in the reaction tubes. It is important that the flow of the gas through the tubes be turbulent. Among the reaction products identified were benzene, toluene, xylene, styrene, indene, naphthalene, anthracene, phenanthrene, chrysene, butadiene, and isoprene. Detailed data, diagrams, and photographs are included.

The Role of the Time Factor in the Acid Treatment of Cracked Distillates. F. SAGER. *Jour. Inst. Pet. Tech.* **20** (1934) pp. 138-44.

Although the literature records the results of many investigations of the acid treating of cracked distillates in which amount of acid, concentration of acid, and temperature has been studied, the information on the effect of time of contact between acids and oil is limited. The results of experiments on the effect of time of contact are recorded. When the time is limited to seconds rather than minutes, polymerization, formation of di-alkyl sulphate, rise of final boiling point, loss in octane number, and so on, are limited. The value of short time is definitely indicated.

The Determination of Specific Refraction and Other Constants As Means of Following the Course of the Treatment of Heavy Oils by the Edeleanu Process. H. I. WATERMAN, P. C. KRUIJFF, W. J. K. SCHONLAU and A. J. TULLENERS. *Jour. Inst. Pet. Tech.* **20** (1934) pp. 159-61.

Differences between the extract and the refined product are in the proportion of aromatic rings and not in average number of rings per molecule. The extract comprises aromatic rings with only a small percentage naphthenic rings; in the refined product a larger number of naphthenic rings are present with a small percentage of aromatic rings, while paraffinic side-chains are longer and more numerous. The average molecular weight of the refined product was higher than that of the extract.

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TYPICAL APPLICATIONS: MAINTAINING THE RATE OF FLOW OF GASES OR LIQUIDS AT A DEFINITE VALUE . . . CONTROLLING THE RATE OF FLOW OF LIQUID OR GAS IN ONE LINE PROPORTIONAL WITH THE RATE OF FLOW IN ANOTHER LINE . . . AND FOR A WIDE RANGE OF PURPOSES SUCH AS CONTROL OF LIQUIDS IN TOWERS AND STILLS.

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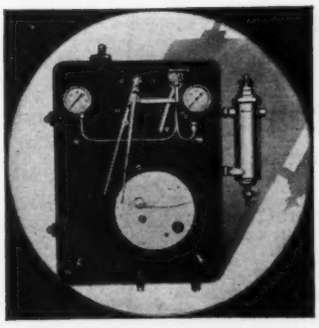

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Products: Properties and Utilization

Thermal Decomposition of Hydrocarbons and Engine Detonation. F. O. RICE. *Ind. & Eng. Chem.* **26** (1934) pp. 259-62.

The author shows a parallelism between knocking tendency and the thermal decomposition of fuels. Thermal decomposition is concurrent with oxidation. As a result of thermal decomposition one molecule of fuel is replaced by several molecules and this increase in concentration may greatly increase the rate of oxidation. Different hydrocarbons yield different numbers of molecules of product from mols decomposed and calculation shows a strict parallelism between this and the knocking tendency of the fuels. Knocking increases with increase in number of mols of product per mol of hydrocarbon originally introduced. Anti-knock compounds may act through their effect on oxidation or on thermal decomposition.

The Danger of Carbon Monoxide Poisoning in Motor-Driven Vehicles. I. FISHER and A. HASSE. *Arbeitsphysiol* 6 (1933) pp. 249-70.

The carbon-monoxide content of the air in closed motor vehicles was determined with palladium chloride. After travelling thirty minutes to one hour the air contained 150-240 cc. of carbon monoxide per cubic meter. The blood of ten conductors and drivers of motor buses was examined and was found to contain 10.17% carboxyhemoglobin as against 3.72% in four control subjects. At the end of nine hours duty with stops at the end of a route there was no important rise in carboxyhemoglobin but with short trips and short pauses the high values ranged from 14.7 to 18.0%. It is suggested that car sickness may result from slight carbon monoxide poisoning and that some otherwise unexplained accidents caused by drivers may be due to this cause.

Oxidation Lubrication and the Blending of Lubricating Oils to Obtain Maximum Lubrication. R. O. KING. *Jour. Inst. Pet. Tech.* **20** (1934) pp. 97-137.

Paraffin base, naphthene base, and asphalt base lubricating oils and various blends thereof were used under conditions of lubrication ranging from mild to very severe. An experimental apparatus and testing machine was used in which the load on a journal bearing was one thousand pounds per square inch of projected area. Experiments were conducted at temperatures from those of the room to slightly over 300°C. The apparatus was so arranged as to permit fairly vigorous

oxidation of the oil in a circulating system. It was found that oxidation caused a marked increase in the temperature at which journal seizure finally occurred. For example, an oil which originally had a seizure temperature of slightly over 150°C. would after oxidation have a seizure temperature somewhat over 300°C. The coefficient of friction also dropped markedly with the development of what the author terms "oxidation activity." A bright stock from Pennsylvania grade crude oil was shown much more resistant than the other oils to oxidation and that its value as a lubricant under severe conditions could be improved by blending it with a less valuable but more easily oxidized oil from an asphaltic crude.

Oxidation Under Pressure. Transformer Oils. L. P. CHEBOTAR. *Jour. Inst. Pet. Tech.* **20** (1934) pp. 168-76.

The subject of auto-oxidation is briefly reviewed. Standard methods of testing the oxidizability of oils, such as those of Michie and Sligh, are found unsuitable. A proper method for the comparison of transformer oils by oxidation under pressure of oxygen at 151°C. is described. The oxidizability is expressed in milligrams of oxygen consumed per 100 milliliters of oil in a given time. A series of anti-oxidants was found for Nujol but none for transformer oils. The observation was made that easily oxidized oils, such as Nujol or paraffin, are classed as very resistant by the results of such a test as Sligh.

Methods for the Control of Lubricating Greases. C. L. KNOPF. *Ind. & Eng. Chem., Anal. Ed.* **6** (1934) pp. 126-34.

The lack of correlation of the results of so-called standard tests and those results obtained under service conditions is stressed with reference to greases. The author describes a number of new tests and instruments specifically devised for the determination of those characteristics of greases not readily obtainable by standard laboratory methods. The pressure viscometer is the proper instrument to use for the control of semi-fluid products such as gear lubricants. The Sinclair pressure viscometer is described. The Sinclair viscidometer is also described. This instrument is used to measure the viscidity of plactic or semi-fluid lubricants. The adherometer is an instrument designed to simulate the sliding of a transmission gear on its shaft. The drip test is used to determine the ability of a chassis lubricant to hang suspended as a ribbon from a hot surface. Chassis lubricants should not drip yet they should feed at a proper rate in the shackles.

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	Naphtha by vol. percent	Spent Doctor by vol. percent	Lead Sulfide by vol. percent
Feed (emulsion)	59.75	33.25	7.0
Naphtha discharge	90.8	4.1	5.1
Spent doctor solution	0.8	89.4	9.8

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Refinery Control Plan Approved P. & C. Committee Expanded

Expansion of the Planning and Coordination Committee "to provide representation for interests not now directly represented" and adoption of a plan for refinery control, the subject of hearings before the Petroleum Administrative Board April 12, was announced by Oil Administrator Harold L. Ickes on April 24. The committee, originally consisting of 15 members, three of whom were administration representatives, has been increased to a total of 26, there being one vacancy.

Under the refinery control plan, said to be a modification of the proposal submitted by Axtell J. Byles on behalf of 24 of the leading companies during the Administrative Board hearings, supervision over operation of the plan is vested in the Planning and Coordination Committee, subject to appeal to and approval by the administrator.

The scheme is a complete substitute for Article IV of the original oil code. It provides for a national co-ordinator of refining operations, allocators of production for the various districts, boards of review and other agencies which would be set up by the Planning and Coordination Committee. The appointment of the national coordinator, however, must be approved by the President.

As a further step toward providing the machinery for enforcement of the new control plan, the refinery committee of the Planning and Coordination Committee has been increased by the addition of Jules Constantin, Overton, Texas, Constantin Refining Company (independent representative); C. M. Boggs, Arkansas City, Kansas, Kanotex Refining Company, (independent); H. A. Logan, Charleston, W. Va., Elk Refining Company (independent); and W. B. Hassett, Ardmore, Okla., president, Imperial Refining Company (independent).

In addition to the sub-committee members announced by the administrator, the Planning and Coordination Committee announced appointments made on its own initiative as follows:

Refining Sub-Committee: Arthur E. Pew, Philadelphia; G. H. Van Senden, New York; George H. Tabor, Jr., New York; Charles B. Buerger, Pittsburgh, and D. G. Gray, Electra, Texas.

"I wish to compliment the industry for its willing cooperation in formulating the refinery plan, worked out along the basic lines suggested to the industry by the petroleum administrative board in a draft proposed on April 5 and subsequently revised, discussed and finally put in form by a committee appointed from various factions within the industry, sitting with the board," Administrator Ickes declared in giving his approval to the plan.

"I feel that this plan, which merits a careful trial and which I expect will have the support of the industry, should prove the remedy for the excessive overproduction of gasoline and other oil products, which is threatening to destroy the national wholesale marketing structure and has already resulted in closing down a number of refineries, with consequent loss of employment.

"I believe that in approving the refinery plan and by increasing the membership of the Planning and Coordination committee, ample opportunity is provided for the industry to demonstrate its capacity to work out its own problems with the federal supervision provided in the amendent."

Refinery Section of Code Rewritten

New Article IV follows:

Section 1. To achieve greater accuracy in balancing production and consumption of gasoline and to prevent the injurious effect on interstate commerce of an unbalanced accumulation of inventories of gasoline in any part of the country or of surplus production and consequent distribution of gasoline in excess of market requirements, a federal agency designated by the President shall divide the country into refining districts and shall (after consultation with the Planning and Coordination Committee and such other sources of information as it may deem necessary) determine from time to time

(1) The proper inventories of gasoline for the country as a whole and

(2) The production of gasoline in the country as a whole necessary to meet the demand therefor, with due regard to normal and seasonal fluctuation in refining operations.

The determinations so made shall constitute the operating schedule for the refining industry in the country as a whole, and same shall be published for at least 20 days before the effective date thereof.

Section 2. The Planning and Coordination Committee shall appoint a national coordinator of refining operations, subject to the approval of the President, and may appoint a district allocator for each district. District allocators shall cooperate with the regional refinery committees and other committees or agencies designated by the Planning and Coordination Committee in making effective the provisions of this article. The Planning and Coordination Committee shall appoint, subject to the approval of the President, a board of review consisting of not to exceed 10 in number, for the purpose of reviewing the findings and allocations of district allocators, the agencies established by the refinery district committees (where no allocator is appointed), and the national coordinator.

Section 3. The national coordinator and the district allocators (or the proper agency established by the refinery district committee where no allocator is appointed), in joint session, subject to the approval of the Planning and Coordination Committee, shall determine from time to time

(1) The proper inventories of gasoline for each district and

(2) The production of gasoline in each district necessary to meet the demand therefor, with due regard to normal and seasonal fluctuation in refining operations.

The determinations so made shall constitute the operating schedule for the refining industry in each district and same shall be published for at

least 15 days before the effective date thereof.

(3) Within the limits of the operating schedule for the refining industry in each district as thus determined, an agency designated by the Planning and Coordination Committee and the district allocator (when one is appointed) in joint session, shall establish fair and reasonable quotas for each refinery operating in the district. In the event of disagreement between a district allocator and the agency designated above, quotas are subject to appeal as herein provided.

In making such allocations the agency and/or district allocator (when one is appointed) shall take into consideration relevant features of operating and marketing conditions under rules and regulations prescribed by the Planning and Coordination Committee and approved by the administrator. Every effort shall be made to avoid inequities which may exist in the availability of supplies of crude oil to refiners necessary to maintain either the proper ratio between inventories and gasoline and sales thereof and/or the production of gasoline authorized in the manner set forth above. No withdrawals of crude oil from storage by or in behalf of any refiner operating only in a single district shall be authorized under the terms of Article III, Section 2, hereof, and/or rules or regulations issued thereunder, unless the application has been referred for advice to said agency and district allocator (when one is appointed) concerned.

Section 4. The national coordinator of refining operations in the case of refiners operating refineries and/or who are maintaining gasoline inventories in more than one refining district, shall adjust such operations and inventories in order that district allocations may be adjusted in such manner as equitably to meet the consolidated requirements of such refiners.

The national coordinator and the district allocators (or the agency established by the refinery district committee where no district allocator is appointed shall meet at such times and places as may be necessary to provide the necessary coordination between districts and uniform application in each district of the rules and regulations provided thereunder. Each district allocator (or the agency established by the refinery district committee where no district allocator is appointed) shall furnish to the national coordinator a complete statement of the allocation made to each refinery in the district and shall furnish such regular reports as may be required by the national coordinator for proper performance of his duties.

No withdrawals of crude oil from storage by or on behalf of refiners operating refineries, and/or maintaining crude oil inventories in more than one refining district, shall be authorized under the terms of Article III, Section 2, hereof, and/or rule and regulation issued thereunder, unless the application has been referred for advice to the national coordinator.

Section 5. Any person may appeal from any recommendation, allocation or decision of the district allocator, agency designated by the Planning and Coordination Committee, agency established by the refinery district committee, or the national coordinator to the board of review provided for above, and the decision of the said board of review shall be final, subject to the right of the Planning and Coordination Committee to review such decision upon appeal, which committee's action, either in respect to the exercise of such right or in respect to the determination made if such right be exercised, shall be subject to the approval of the administrator.

Section 6. In order that provisions of this article may not operate in such

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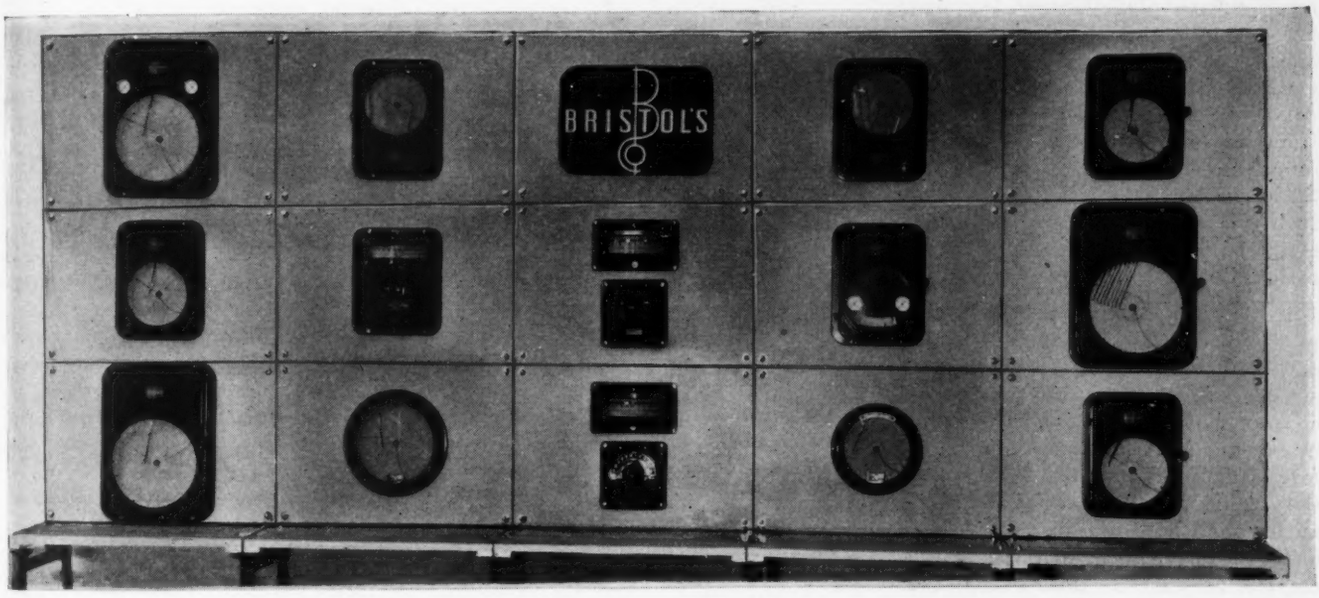

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manner as to discriminate against small refining enterprises and in order to assist in orderly liquidation of excessive gasoline inventories, the Planning and Coordination Committee may, with the approval of the President, authorize suitable arrangements for the purchase of gasoline from non-integrated and/or semi-integrated refiners and the resale of same through orderly channels.

Section 7. Upon a determination by the Planning and Coordination committee that an excessive supply of gasoline or an unbalanced accumulation of inventories of gasoline exists in any district, which excessive supply and/or excessive accumulation of inventories injuriously affect interstate and foreign commerce and is such that any remedy must incidentally apply in like manner to intra-state commerce, the Planning and Coordination Committee may establish fair and reasonable quotas in commerce for gasoline to be moved from all or any of the refineries or other sources of supply in the district. Such quotas shall be in accord with such rules and regulations as are promulgated by the Planning and Coordination Committee.

While such quotas are in effect, no person shall place in commerce or receive in commerce (interstate, intrastate or foreign), by sale, exchange, consignment or otherwise, any gasoline in excess of the quota prescribed. Before establishing quotas for gasoline the Planning and Coordination Committee shall hold or cause to be held, hearings with respect to the establishment of such quotas and to such other matters as in the opinion of the committee may be proper, after such reasonable public notice as may be prescribed; provided, however, that in any emergency as determined to exist by the committee, quotas may be established for a temporary period not to exceed one calendar month without previous notice or hearing, but in such event, the committee in the next subsequent period, shall adjust quotas so allocated upon the basis of due notice and hearing hereinabove prescribed so as to prevent any inequitable allocation. Any person, natural or artificial, aggrieved by any quota, shall have a right to appeal to the administrator.

This section is to be construed and may be enforced without reference to the other provisions of this article.

Section 8. The Planning and Coordination Committee may make such rules and regulations, authorize such committees, and require such reports as it may deem necessary to accomplish the purpose of this article.

Section 9. The word "gasoline" as used herein shall be held to include such products as may be determined from time to time by the Planning and Coordination Committee.

Section 10. In case of any appeal, the appellant shall abide by all the provisions of this article and the rules and regulations issued thereunder pending the decision of such appeal, but in case the contentions of the appellant are upheld in whole or in part an order shall be issued which shall be retroactive to the effective date of the order appealed from.

Section 11. Failure on the part of any person to observe or comply with any provisions of this article or any valid order, rule or regulation hereunder, shall constitute a violation of the code.

N. P. A. Meeting Studies Economics and Marketing

THE semi-annual convention of the National Petroleum Association at Cleveland last week was addressed by a group of speakers discussing present day marketing problems and improvements in the industry's economic situation. Charles L. Suhr, The Pennzoil Company, president of the association, in his opening address stressed the necessity for self government for the oil industry.

Suhr stated that "just recently the refining branch of the industry, large companies and small companies alike, has reached a substantial agreement with respect to an amendment to those sections of the code for the petroleum industry which deal with refining and this agreement will soon be embodied in the code. At the same time, the Planning and Coordinating Committee is enlarged so as to make it more representative of all groups within the industry.

"As I interpret these vital changes in the code, they mean that we have committed ourselves to a program of self-government. We have said to the federal government and to the public 'We ourselves will control our refinery operations.' The Petroleum Administrative Board, which determines the allowable production of crude oil for the country as a whole, will also determine, after conferences with the Planning and Coordination Committee, the total quantity of gasoline which may be produced in a given period. From that point, the code, as it is to be written, will place squarely upon the industry the allocation of gasoline among districts and to individual companies."

H. J. Struth, special technical adviser to the Petroleum Administrative Board, expressing his views only, stated that the amended refinery control plan offers a way out of existing difficulties, but that it offers little more than previous plans, unless there is wholehearted, unselfish effort on the part of every refiner in the country to abide by the principles set forth in the new control plan. Struth pointed out that the industry had not eliminated overproduction of crude nor reduced refinery operations to conform with expert studies of consumptive demand. "True," he stated, "since the oil code became effective, we are able to point out a reduction in reported crude output amounting to about 330,000 barrels daily, a reduction in refinery still runs of 243,000 barrels daily, a reduction in foreign oil imports of 57,000 barrels daily. Meanwhile, our market situation, both wholesale and retail, has passed through another siege of crumbling values that had, up to a few days ago, exacted a further heavy financial toll from which few companies were able to claim immunity." He stated further that the industry is endowed with a demand for gasoline and other products of the refinery that is far ahead of all other basic industries. The immediate outlook indicates that the industry probably will experience an increase in gasoline demand this year of more than five percent, and with normal values, this increase in demand should offer an opportunity for profit.

In conclusion, Mr. Struth stated "The extent to which the industry will profit from its immediate demand outlook depends primarily, upon the degree with which production is controlled. If everyone in the industry will follow out the newly amended refinery control plan, I am confident that the high-consuming months for gasoline, immediately ahead, will enable all to conduct their operations at a profit. There is much behind the control program, but in order to attain the benefits desired, it will be necessary for the entire industry to first get behind the program of production control."

Albert W. Atwood, editorial writer for the, Saturday Evening Post, discussed the present day challenge to business leadership. He pointed to the present currents and counter-currents

MISTAKE

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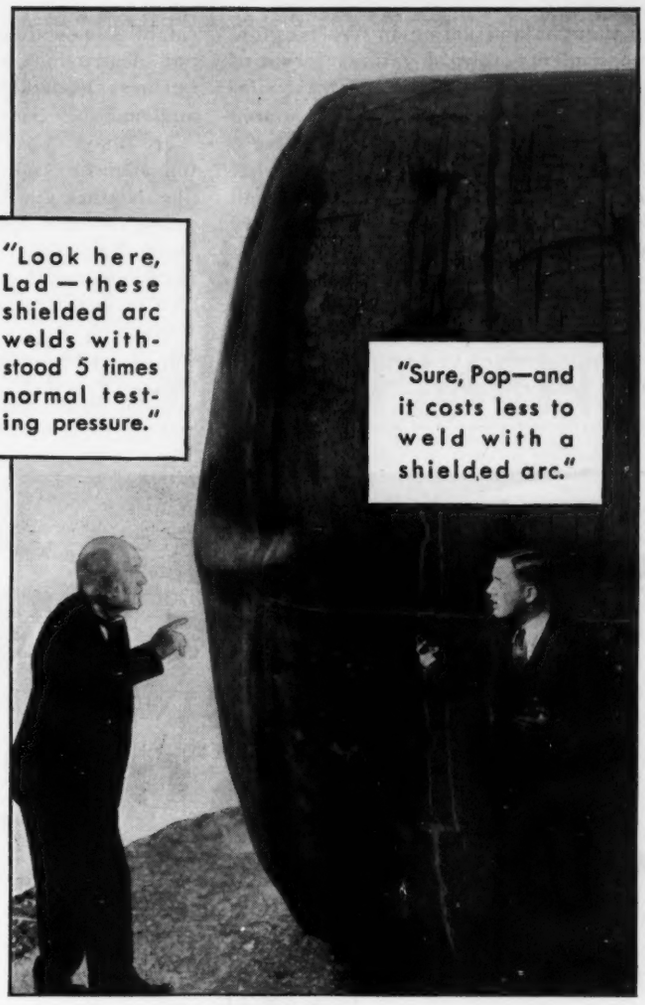
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of thought and action in Washington, the tendency toward various forms of governmental practices, and to revolutions in foreign countries, but stated "We need a little perspective in these matters. I agree with Dr. Moulton, that the fear that the present trend will permanently paralyze private initiative is not well founded. It is possible, he says, to greatly extend the field of government supervision over codes, for example, with destroying the necessary incentives to progress. We may place competition on a new plane and establish new boundaries for it without destroying it. The challenge to business leadership is to keep steady and not be frightened, even though there may be very much in present tendencies or policies which you do not like. Neither you nor the professors are going to build Utopia in a hurry, and human institutions do not change as fast as some people, suddenly come into power, imagine."

"It is a literal fact," Atwood continued, "to say that you as business leaders that you have the great function of keeping the wheels going, that in the long run the government can only help, that you must provide the bulk of employment, for both men and dollars, that you must pay the taxes to enable the government to do what it does, wisely or unwisely, and that you should be proud to do your part. Personally I do not think the business leaders of this country make it sufficiently clear to the public what a vital part they do play. They should be ashamed of their mistakes, but very proud of their great and real achievements."

In speaking of the extremist tendencies of certain groups, Atwood said, "You as oil men, were the threatened victims a year or two ago of the farm lobby that wished to have legislation compelling you to use alcohol in your gasoline. That was but a symptom. Several similar if not as unsound hold-ups have been put over since. There is a dangerous tendency abroad today for groups of producers to seek to enslave the consumer, to kill competition, to kill substitutes, to block the progress of science and invention, not by trying to find a sane balance, which is both defensible and desirable, but by arbitrary strong arm methods, by lobbies, by threats, by political pressure. Sound business leadership must stand out against such measures and politics, and must oppose, not only by lip service, but in action."

Dr. H. C. Mougey, chief chemist, General Motors Research Corporation, presented slides illustrating a paper which will be presented at the summer meeting of the Society of Automotive Engineers by Upham, Graves and Mougey. His discussion indicated a preference for lighter automotive lubricating oils. He presented results of both cooperative and individual company research investigations on the problem of cold starting of motors and other lubricating problems. Of the three methods for improvement in starting, i. e.—more volatile gasoline, strong batteries, and decreased oil friction by proper viscosity selection, the latter seems the proper course to follow. The same results desired in ease of starting can be secured more cheaply and satisfactorily by reducing the viscosity of the lubricant and therefore its friction drag, and a large number of exhaustive investigations prove this contention.

General Motors has sent test fleets of cars to Regina, Saskatchewan, Canada, during the winters of 1931 and 1933 for study of cold starting and cold weather performance. Temperature range was from 44°F above to 44°F below zero. These investigations

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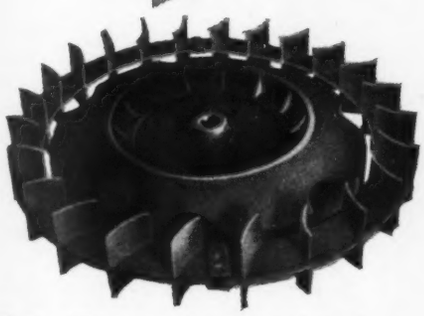

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proved that while certain starting could be secured at the higher temperatures with a relatively heavy oil, for example, S. A. E. 30, such oils would not perform at the lower temperatures experienced. Thus, the motorist should be provided with the lubricant that gives most satisfactory performance at the lowest temperatures likely to be encountered.

The lighter crank case oils, Mougey said, gave more brake horsepower, more torque, less engine friction and less fuel consumption. The 10-W and 20-W motor oils, are in some cases also classifiable as S. A. E. 10 and S. A. E. 20 oils. The suitable crank case oil must furnish adequate lubrication and while permitting easy starting in cold weather, it must also give reasonable lube oil mileage. In testing S. A. E. 30 oil and 10-W oil under set conditions it has been found that while the lighter oils show slightly higher consumption, this is more than offset by decrease in gasoline consumption.

Sidney A. Swensrud, Standard Oil Company (Ohio) in his paper "Comments on Current Marketing Problems" discussed the demands on the government by marketers for wider fixed margins on gasoline to offset the profit lost due to decreases in gallonage. He contended that wider margins would eventually prove destructive through increasing competition of low cost outlets such as trackage stations, cooperatives, and similar marketing set-ups.

Arthur E. Pew, Sun Oil Company, discussed the problem of allocating gasoline production and stocks to various refining districts and to individual plants. He stated that before stock allocations can be intelligently made there must of necessity be a detailed study of the requirements of refiners that use the various methods of transporting their products. Minimum stock requirements of refiners that ship by pipe line or by tank car are very different from those shipping by tank steamer over long distances for eventual distribution from water terminals. Mr. Pew's personal view was that such a study should start with the operations of the 24 companies which evolved the compromise refinery control plant. Study of the operations of these companies, he said, would indicate what the various districts require as minimum working stocks during the various seasons of the year. Upon setting up the district quotas on a minimum requirement it would then be possible to make allocations to various companies based on their type of operations. He expressed the opinion that since crude oil can be so speedily converted into gasoline it is of little importance whether oil is stored above or under ground, and that the pressure of crude on the market is the factor which keeps gasoline weak.

Willis Crane, associate counsel for the association presented a paper on the federal gasoline and lubricating oil taxes, in which he stated that one of the dangers confronting the industry in the 1934 revenue bill is the loss of ability to make tax free sales. The situation now seems to have been met in the senate version of the law and it is probable that tax-free sales can be made in future transactions about as they have been during the 1933 law. He stated that the Bureau of Internal Revenue is at present making additional tax assessments on some transactions made under the tax law of 1932, and suggested that full information and facts in such cases be laid before the Bureau for the reason that the Bureau does not wish to assess a tax in any case where a tax has already been paid.

The paper, "Progress in Air Trans-

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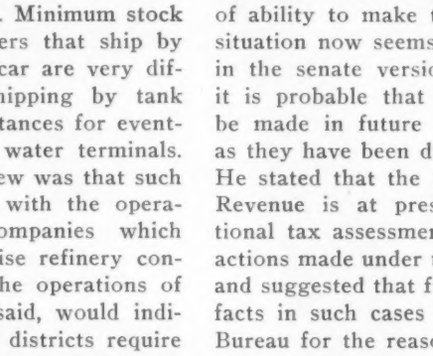

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portation" by Cyril C. Johnson of United Air Lines, included a discussion of the danger of high taxes on motor fuels as a menace to profitable commercial aviation development. Taxation is more important to the aviation industry than to the automotive because of the amount of fuel used per machine per passenger mile, and therefore the percentage of total operating cost represented by fuel costs is correspondingly greater. He pointed out that gasoline taxes have for the most part been spent to improve highways on which the gasoline is consumed by passenger cars, trucks and busses for which the motors get the benefit. This is not the case with aviation, he stated, and showed that a tax of 7 cents per gallon as in Tennessee, plus the federal tax, amounts to 4.2 cents per scheduled mile on 46 million miles flown in 1932. The same tax on both motor and aviation fuels puts a 20 to 1 handicap on the latter. An airline, he stated, consumes ten times as much fuel in carrying half as many passengers the same distance, compared to the motor bus. Air lines consume about one gallon per mile of flying.

Scheduled miles flown in 1933 totaled more than 48 million, about a 1000 percent increase over 1927. Flying speeds have about doubled during the same period. In 1933 flying speeds jumped from 115 miles per hour to an average of 165 miles per hour. Statistics have shown that each time there has been a speeding up of air travel, traffic has increased and the average ride has been lengthened. Likewise, speedier planes have brought an increase in night flying, which afford a maximum of time saving when measured in terms of business hours.

Interesting Papers for Chemical Engineers Meeting

THE program for the semi-annual meeting of the American Institute of Chemical Engineers, which will open at the Waldorf Astoria Hotel, New York, May 14, includes several papers of value to the petroleum refining industry. One of the inspection trips planned by the chemists includes an afternoon visiting the hydrogenation plant and other processes at the Standard Oil Company of New Jersey refinery. Later the R. C. A. studios and Rockefeller Center will be visited. Among the papers of interest to the industry are the following: "A Study of Entrainment in a Bubble Cap Distillation Column," G. E. Holbrook and E. M. Baker; "Studies in Agitation," Part IV, A. McLaren White, and Edward Brenner; "Continuous Rectification of Binary Mixtures," J. S. Carey, J. Griswold, W. H. McAdams and W. K. Lewis; "Fractional Distillation"—Part 1, George Granger Brown and Mott Souders, Jr.—Part 11, George Granger Brown, Mott Souders Jr. and William W. Hesler. Several other papears dealing with various chemical or process industries will be presented.

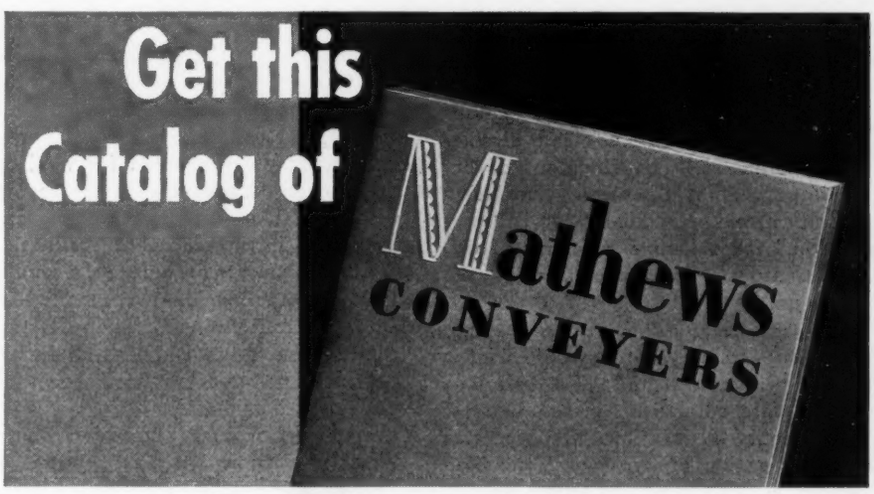
Drake Well Memorial Ceremony Is Planned

A FOUR-DAY celebration of the seventy-fifth anniversary of petroleum in the United States will be held at Titusville, Pennsylvania, August 24-27, when Drake Well Memorial Park will be formally dedicated. The thirty-acre tract, purchased with funds contributed principally by members of the American Petroleum Institute, surrounds the location of the oil well drilled by Colonel Edwin L. Drake, which dates the beginning of oil as an industry in America. Though there has been controversy on the subject, Titusville citizens have agreed that the date of the completion of the Drake well was Saturday, August 27, 1859.

The principal ceremony attending the four-day Diamond Jubilee of Oil will be the formal transfer of the property from the American Petroleum Insititute to the Commonwealth of Pennsylvania. Axtell J. Byles, president of the Institute, will make the presentation, and it is expected that Governor Gifford Pinchot will make the address of acceptance for the Pennsylvania Historical Commission. Secretary of the Interior Harold L. Ickes, Federal Oil Administrator, also will be invited to deliver an address.

The park has been developed around the site of the present Drake Memorial, a one-acre plot which was transferred to the American Petroleum Institute by the Titusville chapter of the Daughters of American Revolution.

A museum and caretaker's residence have been constructed, and the park will be ready for visitors by mid-summer. A portion of the park has been landscaped, but in the main it has been left in its natural state. It is contemplated later to restore the oil pits that were on the property.



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New Edition of A. S. T. M. Significance of Tests

A. S. T. M. Committee D-2 on Petroleum Products and Lubricants has nearly completed a revision of the booklet "Significance of Tests of Petroleum Products," first published in 1928. The publication has been particularly useful to both producers and users of petroleum products and has had a wide distribution. The new edition is to be completely revised and enlarged.

Important Decision In Cracking Field

UNIVERSAL Oil Products Company, in its suit against Root Refining Company in the Federal District Court of Delaware, at Wilmington, has established the validity of two important patents covering the Dubbs cracking process and proved they were infringed through the operation of Winkler-Koch type cracking units in Root Refining Company's plant at El Dorado, Arkansas. The opinion handed down by Judge John P. Nields, April 27 finds that both patents in the suit are valid and that they were infringed.

The two patents in the suit are No. 1,392,629, issued to Carbon P. Dubbs, October 4, 1921, and assigned to Universal Oil Products Company, and No. 1,537,595, issued to Gustav Egloff, May 25, 1925—also assigned to Universal Oil Products Company. The Dubbs patent is the so-called clean circulation patent. The Egloff patent covers an improvement of clean circulation operation, the so-called "two-coil operation," for selective cracking of different stocks simultaneously in the same unit.

The validation of these two patents is of importance to the whole of the refining industry, and this suit has been watched with great interest throughout its duration. The suit was a consolidation of two cases, one filed March 11, 1929, and the other July 7, 1931, Root Refining Company, being the defendent in both cases. Trial of the case was begun June 21, and the hearing ended July 28, 1932. On one side was the owner of a process developed under patent protection and operated under license agreement, and on the other, an operator of unpatented and unlicensed cracking units, challenging the validity of the patents involved and denying infringement. Infringement of all the claims in the Egloff patent was charged by the plaintiff and all of the claims except one, in the Dubbs patent.

Witnesses in this case included R. W. Hanna, vice president of Standard Oil Company of California; Daniel Pyzel, chief technologist of the Shell Companies in the United States, and H. J. Halle, president of Universal Oil Products Company.

Hanna and Pyzel testified that their companies paid large sums in royalties because they believe clean circulation, as covered by the Dubbs patent, to be vital to economical cracking. They and Halle traced the history of development of the Dubbs cracking process. The technical witnesses for Universal Oil Products Company were Dr. Warren K. Lewis, professor of chemical engineering of the Massachusetts Institute of Technology, and Dr. George Granger Brown, professor of chemical engineering of the University of Michigan.

Dr. Walter Rittman, professor of commercial engineering at Carnegie Institute of Technology, Pittsburgh, was the technical witness for the defendents.

It is understood that Universal Oil Products Company now plans to proceed vigorously against infringers of its cracking patents.

Statement of Withdrawal Issued by Foster Wheeler

FOSTER WHEELER CORPORATION announces its complete withdrawal from Petroleum Distillation Corporation as of December 31, 1933. Under the withdrawal agreement the original purchasers of equipment constructed or contracted for by Foster Wheeler Corporation prior to December 31, 1933, are protected against claims for infringement of distillation patents issued on or before December 31, 1933, and owned or controlled by The Atlantic Refining Company, Standard Oil Company (Indiana), Standard Oil Company of New Jersey or their controlled subsidiaries.

In return for such protection Foster Wheeler Corporation has granted to Petroleum Distillation Corporation non-exclusive licensing rights under Foster Wheeler distillation patents issued on or prior to December 31, 1933, and without accounting to Foster Wheeler.

All stock formerly held by Foster Wheeler Corporation in Petroleum Distillation Corporation has been reassigned to the latter without other consideration and the agreement whereby Foster Wheeler Corporation was licensing agent for Petroleum Distillation Corporation has been terminated. Every connection between Petroleum Distillation Corporation and Foster Wheeler Corporation has now been entirely severed.

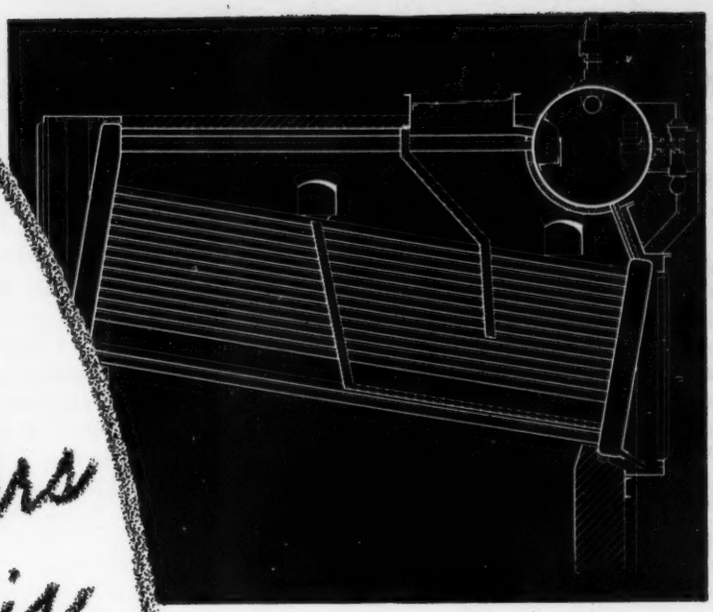
Handbook of Chemistry and Physics

FOR 20 years the Handbook of Chemistry and Physics has been of service to those in need of accurate tables, formulae and scientific data in a single volume. The eighteenth edition, now being distributed, is edited by C. D. Hodgman, professor of physics at Case School of Applied Science, and is published by the Chemical Rubber Publishing Company. The present edition represents a 20-year accumulation of necessary data for the busy scientist and engineer. Following past practice in keeping the book up to date, much new material has been added and the old material revised. The description matter concerning the elements has here completely renewed and all recently discovered elements added. Physical constants on 4000 inorganic and metal-organic compounds are included. There are comprehensive sections on mathematical tables and formulae, chemical tables, properties of matter, heat, sound, electricity, magnetism, light, measures and unit. Other revisions and enlargements have been made under such subjects as pH values for potentiometer readings, organic analytical reagents, degrees-radians, optical rotation of acids and bases, solubility charts, volumetric primary standards, efficiency of drying agents, liquids for index by immersion, factors and primes, isotopes, etc. Copies of the handbook can be secured through the Book Department, Gulf Publishing Company, Houston, Texas. Price $6.00.

W. P. R. A. Tractor Fuel Specifications

WESTERN Pertoleum Refiners Association at its recent meeting adopted specifications for tractor fuel which are representative of specifications in force in several middle western states. The specifications set up by several states for guidance in tax exemption, show considerable variation, and the committee of the association strove to prepare a specification which would permit shipment of tractor fuel into any of the states now having standards. Likewise, the specification is intended to serve as a guide to those states contemplating legislation regarding tractor fuels. Refiners can ship heavier tractor fuels than indicated by the W. P. R. A. specification, but can not ship lighter fuels with expectation of securing tax exemption in all states. The specification adopted follows: (Minimum) flash, 110°F., closed cup; 10 percent over at 347°F.; 25 percent over at 392°F.; 90 percent over at 465° F.; color, minus 16 or darker.

38 orders totaling 122 C-E Boilers from this Refiner*



The above unit is one of four C-E box header boilers constituting the thirty-eighth individual contract placed for Combustion Engineering Company's boilers by the prominent oil refiner operating the plant where this unit is in operation.

Equipped to Burn either Oil Sludge, Waste Gas or Pulverized Fuel . . .

AN interesting and significant feature of the installation here illustrated is the fact that this unit is equipped for burning either oil sludge, waste gas or pulverized fuel. This arrangement is of course in line with the best practice for maximum steam production economy in refineries where petroleum coke, by-product fixed gases, tower bottoms, sludge, etc., are available for boiler room use, supplemented with purchased fuel as needed. That this boiler, with three others, comprises the 38th order for C-E boilers received from a single petroleum refiner is strong evidence that Combustion Engineering equipment and service meet the steam plant needs of the modern refiner in a manner that assures lasting satisfaction. We invite you, too, to avail yourself of these C-E facilities. A special plan is offered to assist you, without red tape or obligation, in determining how much your present steam costs can be reduced. *Use the coupon below.*

**Name on request.*

COMBUSTION ENGINEERING COMPANY, Inc.

200 MADISON AVENUE • NEW YORK, N. Y.

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Canadian Associates, Combustion Engineering Corp., Ltd., Montreal

C-E Products

Boilers
Stokers
Pulverized Fuel Systems
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A complete line of boiler, fuel burning and related equipment

COMBUSTION ENGINEERING COMPANY, INC.
206 Madison Avenue, New York

Please acquaint me with your plan to help me to determine how much my steam costs can be reduced. We operate.....of.....hp.
(No. of boilers) (Total boiler hp. capacity)

Name ..... *Title*.....

Company .....

Address .....

A. P. I. Mid-Year Meeting Program

THE fourth mid-year meeting of the American Petroleum Institute at Pittsburgh, May 22, 23 and 24, includes three technical sessions of the Division of Refining, four sessions of the Division of Production and two sessions for the Division of Marketing. About 30 committees of the institute will hold sessions on Tuesday, May 22, preliminary to the sessions of the three divisions, Thursday and Friday. One general institute session will be held, Wednesday afternoon, May 23.

The Refining Division sessions, Wednesday morning, Thursday morning and afternoon include a program of 12 papers. Two of the sessions are on refinery problems, and one on automotive problems.

Reduced railroad rates have been authorized for the meeting on the basis of fare and one third for the round trip. Identification certificates necessary to obtain the reduced rates are sent out by the institute to members.

Following is the program for the Division of Refining, which will be held in the William Penn Hotel:

Wednesday, May 23—10 a.m.

Refinery Problems

"Continuous Treating of Oils with Centrifugal Separation" — Robert D. Walker, The DeLaval Separator Company.

"The Use of Centrifuge in Acid Treating Petroleum Stocks." Leo D. Jones, Sharples Specialty Company.

"The Maxam Method of Acid Treatment of Heavy Lubricating Oil."—F. M. Tomlinson, The Maxam Company.

"Percolation Filtration in the Light of Recent Process Developments."—Stanard R. Funsten, Attapulgus Clay Company.

"Economies in Refinery Operation in Relationship to A. P. I. Standardization Program."—Arthur E. Pew, Jr., Sun Oil Company.

General Session—2 P. M.

Production, Refining and Marketing

Address—Axtell J. Byles, American Petroleum Institute.

Address—W. R. Boyd, Jr., American Petroleum Institute.

Address—Baird H. Markham, American Petroleum Industries Committee.

Thursday, May 24—10:00 A. M.

Automotive Problems

Economic Discussion of Methods of Obtaining High-Octane Gasoline.—Speaker to be announced.

The Relation of Fuel Octane Number and Engine-Compression Ratio.—Earl Bartholomew and C. D. Hawley, Ethyl Gasoline Corporation.

Conservation of Volatile-Gasoline Materials.—William Mendius and Walter Ainsley, Sinclair Refinnig Company.

Butane—A Waste Asset of the Petroleum Industry.—R. C. Alden, Phillips Petroleum Company.

2:00 P. M.

Refinery Problems

The Problem of Viscosity of Lubricants.—M. R. Fenske and W. B. McCluer, The Pennsylvania State College.

The Economics of Solvent Extraction of Lubricating Oils.—R. E. Wilson, Standard Oil Company (Indiana), and P. C. Keith, M. W. Kellogg Company.

The Distinction Between Heavy Fuels for Use in Spark and Compression-Ignition Engines.—James B. Fisher, Waukesha Motor Company.

The following committees in the Division of Refining will hold meetings during the convention:

Division of Refining, General Committee—Chairman, Howard Bennette; Secretary, R. P. Anderson.

Committee on Standardization of Refinery Equipment—Chairman, A. E. Pew, Jr.; Secretary, R. P. Anderson.

Committee on Testing Methods and Specifications—Chairman, K. G. Mackenzie; Secretary, R. P. Anderson.

Central Committee on Refinery Technology—Chairman, R. E. Wilson; Secretary, R. P. Anderson.

Committee on Disposal of Refinery Wastes—Chairman, John S. Hess; Secretary, D. V. Stroop.

A. S. M. E. Petroleum Division Program

THE American Society of Mechanical Engineers, Petroleum Division, holding its 1934 annual meeting in Tulsa, May 14 to 17, in connection with the International Petroleum Exposition, has scheduled an interesting program dealing with problems in refining, production and transportation. Headquarters during the meeting are in the Club Room, Tulsa Hotel. The first day of the meeting is given over to refining, the second day to production and the third to transportation. The program for the refining session follows:

"Minimum Thickness to which Refining Equipment Should be Allowed to Corrode," Mr. Newcomb, Standard Oil & Development Company, Elizabeth, N. J.

"Refining Fuel and Combustion Data," O. F. Campbell, Sinclair Refining Company, East Chicago, Indiana.

"Friction in Baffled Tube Bundles," B. E. Short, University of Texas, Austin, Texas.

"Heat Transfer Rates on Condensing, Reboiling and Miscellaneous Heat Exchange Service," Max Higgins, The Texas Company, New York.

"The Use of A. S. T. M. Temperature-Viscosity Charts for the Blending of Lubricants," J. P. Calderwood, Kansas State College, Manhattan, Kansas.

"Application of Fouling Factors in the Design of Heat Exchangers," E. N. Seider, Foster Wheeler Corporation, New York.

"Rates of Heat Transfer to the Radiant Heat Absorbing of Pipe Stills," Charles E. McCullough, Foster Wheeler Corporation, New York.

A. P. I. Joins A. S. A.

THE executive committee of the American Petroleum Institute's board of directors at its last meeting in New York voted that the institute take out a membership in the American Standards Association. R. P. Anderson will represent the institute on the council of the A. S. A. and Carl A. Young will act as alternate.

T. J. SULLIVAN, Gulf Refining Company, Port Arthur, Texas, has been appointed a member of the American Petroleum Institute, Division of Refining, Committee on Disposal of Refinery Wastes, succeeding G. H. Westbrook of the same company, resigned.

WILLIAM B. WALKER, president of Standard-Vacuum Oil Company, died April 13 at Mayo Clinic, Rochester, Minn., following an operation. He leaves his wife and four sons. Late in 1933 he became the first president of the newly organized Standard-Vacuum Oil Company, brought about through the merger of the Far East properties of Standard Oil Company (New Jersey) and Socony-Vacuum Corporation.

JOHN F. JAHNE, refinery engineer, and member of the refinery processing committee Socony-Vacuum Corporation, died March 28 after a brief illness. He had been with the organization since 1916. He was chief engineer and assistant superintendent at the Paulsboro, N. J., works for several years, and after the merger of Vacuum Oil Company and Standard Oil Company of New York, was transferred to the New York headquarters.

RAY E. MILLER

RAY E. MILLER, for the past five years secretary and manager of the Natural Gasoline Association of America, has resigned to become vice president and manager of sales for Hanlon-Buchanan, Inc., Tulsa. He succeeds A. F. Wood who resigned to become president of the newly formed Wood-Moore Corporation.

WALLACE G. Corwin, assistant superintendent Franklin Railway Oil Corporation refinery at Franklin, Pennsylvania, is spending several weeks in Germany in the interest of his company, making headquarters at Hamburg.

J. A. JOHANNES, Phillips Petroleum Company, formerly at Cromwell, Oklahoma, has been transferred to the natural gasoline department in the Oklahoma City field.

GEORGE H. L. KENT, formerly with Humble Oil & Refining Company, engineering department, is now with Hanlon-Buchanan, Inc., in gasoline plant work in East Texas.

H. C. WAKEFIELD, assistant superintendent of The Texas Company's Casper, Wyoming, refinery has been transferred to the company's plant at Pryse, Kentucky. En route he stopped at the Port Neches plant for 30 days training in asphalt manufacture. P. Beal, formerly manager of the company's refinery at Cody, Wyoming, which is now shut down, succeeds Mr. Wakefield as assistant superintendent of the Casper plant.

PLANT ACTIVITIES

Cracking Units: Rio Grande Oil Company, Los Angeles, California subsidiary of Consolidated Oil Corporation, is dismantling its two Jenkins cracking units to erect larger cracking equipment of Sinclair type. A. E. Greenberg, chief engineer, in charge of new plant design and construction at the Vinvale plant.

Improvements: Texas-Elf Carbon Company, subsidiary of Godfrey L. Cabot, Inc., is installing equipment in a second Texas Panhandle carbon black plant known as the Spheron process for converting carbon black from powdered to granular form.

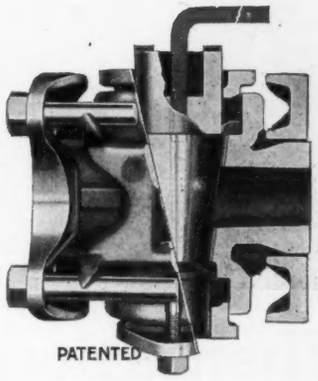
Operating: Federated Distributors Syndicate, Ltd., Midnapore, Alberta, Canada, has started operations at 350 to 400 barrels daily. F. R. Rogers is manager.

Stabilizer: J. J. & M. Taxman Refining Company, Wichita Falls, has started operating its new Petroleum Engineering Inc. vapor recovery and stabilizing unit designed to process 800 barrels daily of pressure distillate and 1,000,000 cubic feet of refinery and cracking plant gases.

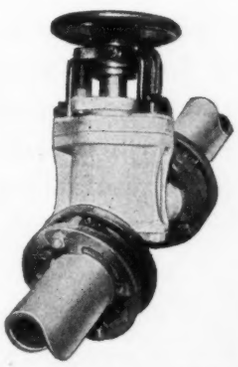
CAN YOU AFFORD THE COST *of* CORROSION?

CORROSION of valves handling acids and acid sludges is a major item of expense. It involves not only the cost of the valve, but the labor cost of replacement.

DURIRON Valves will handle all kinds of acids at all concentrations and temperatures. And Duriron Valves are "utility" valves—one valve can be used for any acid service in the refinery . . . on unloading lines . . . at the concentrator . . . on sludge acid transfer lines . . . at the treating plant. And even though there is grit in the material being handled, the hardness of Duriron protects it from scouring.



DURIRON "PR" Plug Valve



DURIRON Y Valves in sizes from 1 to 6"

DURIRON Valves are made in several types and sizes. We will be glad to suggest the particular type that will best solve your particular problems.

THE DURIRON COMPANY, INC.
412 N. Findlay St., Dayton, Ohio

DURIRON
FOR ACID SERVICE

Shut Down: Humble Oil & Refining Company, has shut down its natural gasoline plant in the Yates field, West Texas.

Gasoline Plant: Carter Oil Company, Tulsa, is building a two-unit compression type gasoline plant, small production, and chiefly for returning gas to the oil bearing sands in the South Osage field, Oklahoma.

Gasoline Plant: Phillips Petroleum Company is erecting a 15,000-gallon gasoline plant in the Osage field, Oklahoma, Section 16-24-70 on Federal Naval Reserve, setting 12 compressor units. Most of the residue gas to be returned to producers for repressuring work.

Gasoline Plant: O. H. Grimes, Tulsa, is operating gasoline plant, Greendale Township, Midland County, central Michigan field, capacity three to five million cubic feet of gas daily. R. H. Chisholm is manager.

Gasoline Plant: Skelly Oil Company, Tulsa, has let contract for equipment for a 10,000,000-cubic foot combination compression-rectification type gasoline plant to be located in the South Burbank field, to Petroleum Engineering, Inc., associated with Arthur G. McKee & Company.

Plant: The Texas Company, in Foard County, Texas, has completed construction of a combination crude reducing-vapor rectification type of plant, designed for processing 10,000,000 cubic feet of gas and 3500 barrels of crude oil. Contract to Petroleum Engineering, Inc., associated with Arthur G. McKee & Company.

Cracking Unit: Burlington Oil Refineries, Ltd., A. Woodburn, Engineer, 1210 Piggott Building, Hamilton, Ontario, Canada, plans construction of cracking unit at its refinery.

Stabilizing Unit: Shell Oil Company of California, Martinez plant, has awarded contract for pressure distillate stabilizing unit to Alco Products, Inc.

Improvements: Gulf Refining Company, Philadelphia, has awarded contract for additions and improvements, solvent refining system, to Lummus Company; reported expenditure, $1,000,000.

Gasoline Plant: American Natural Gasoline Company is building a natural gasoline plant near Shamrock, Texas Panhandle, with capacity of 35,000 gallons daily.

Asphalt Plant: Wirt Franklin Corporation, Ardmore, Oklahoma, refinery is completing construction of 1000-barrel asphalt plant; contract to Arthur G. McKee & Company.

Building: Sunray Oil Corporation, Allen, Oklahoma, has construction work well under way on its new Dubbs cracking unit; contract to Foster Wheeler Corporation.

Enlargement: National Supply Company at its Lela gasoline plant in the Texas Panhandle is increasing capacity through installation of new equipment and rehabilitation of the older equipment.

Operating: O. C. Fields Gasoline Corporation, Huntington Beach, recently placed its new combination absorption-compression natural gasoline plant in operation. Capacity, 50,000 gallons daily. Contract, Fluor Corporation.

When is the contract fulfilled?

Legally, when the parties to it have done everything they agreed to do. But the manufacturer whose name on a piece of machinery has stood for quality and dependability for a half century or more, knows that his product must meet an implied obligation long after the technicalities of the contract are forgotten. Year after year it must perform at high efficiency and with low maintenance expense . . . year after year it must provide dependable and trouble-free service . . . year after year, throughout a long life of usefulness it must fulfill the unwritten guarantee which its name carries with it.

YORK ICE MACHINERY CORPORATION • YORK • PENNSYLVANIA

REFRIGERATION • ABSORPTION & COMPRESSION

COMPLETE BRIGHT STOCK PLANT DESIGN

New Equipment for the Modern Plant

Power Clutch

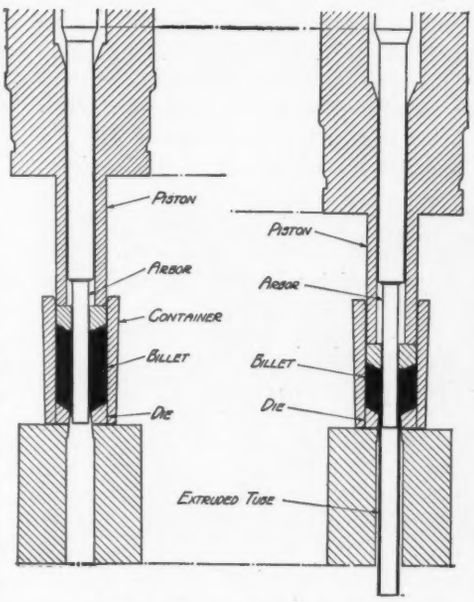
HARNISCHFEGER CORPORATION

Harnischfeger Corporation, Milwaukee, Wisconsin, has developed a sensitized power clutch for use on excavating equipment and cranes. The manufacturer claims the clutch will increase digging speed and prevent motor stalling while handling maximum loads.

Condenser Tube

THE AMERICAN BRASS COMPANY

The American Brass Company, New York City, announces development of extruded, rolled and drawn condenser tubes, which are available in both standard and special alloys, under the name Anaconda Extruded Condenser Tubes. They are produced by extruding cast billets which previously have been machined to remove surface irregularities, insuring a clean surface, inside and out, free from foreign matter and defects. After extrusion, the tube is cold swaged-rolled on a mandrell by a new process said to preserve and improve the smoothness of the inside surface. This operation, a combination of forging and rolling, works the metal throughout its entire cross section, completely changing the grain structure.



American Brass Condenser Tubes

The extrusion process is employed in production of both brass and copper-nickel alloy tubes. The tubes are made of Anaconda Super-Nickel, Ambrac Metal, Aluminum Brass and Admiralty Metal.

Automixer

WALLACE, MULLER & CO., LTD.

Wallace, Muller & Company, Ltd., 75 West Street, New York City, are sales agents for the Thiberge AutoMixer, a new and radically different type of lubricating oil blending machine. Sun Shipbuilding and Dry Dock Company, Chester, Pennsylvania, manufactures and fabricators oil refinery and industrial equipment, has signed contract to manufacture the machines. The machine is being exhibited and demonstrated at the International Petroleum Exposition, Tulsa, this month.

The machine employs a unique adapta-

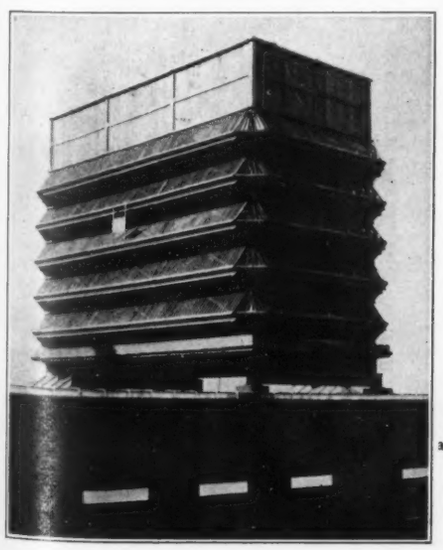
Two Exclusive Advantages

Found in No Other Deck Type Cooling Tower

ONE—the Marley spray system that provides better water distribution and finer break-up. TWO—the Marley louvred louvre that controls air circulation, provides more air at uniform velocities and reduces moisture entrainment and drift loss to a minimum.

These two patented features alone will save you many dollars in tower operation costs. Other improvements add further to the efficiency and economy of these Marley towers. Write for detailed information.

THE MARLEY COMPANY, 1915 Walnut, Kansas City, Mo.



Roof mounted Marley spray deck tower for air conditioning service.

MARLEY
COOLING SYSTEMS

Marley steel frame spray deck tower serving an ammonia refrigerating system

Marley patented spray nozzles are used in all Marley cooling systems.

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because it's
SIMPLER

Williams' REVERSIBLE "Vulcan Boll-Weevil" is simplicity itself. That goes for its *construction* as well as operation.

It has only six parts. All are so constructed and assembled as to minimize breakage, wear, or trouble of any kind. The "I-beam" handle lends extreme rigidity and strength. Two bolts secure the jaws positively—they cannot spread.

Throughout, it is a sturdy, low-upkeep Tong adaptable for general oil field and refinery use; particularly efficient and rapid on pipe line work.

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WILLIAMS
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REVERSIBLE TONGS

tion of the split-stream principle in proportioning the components to be blended, and it is said that the mixing is so exact that the machine can be used to blend several oils directly into a line leading to tank truck or tank car without intermediate storage or further mixing.

The AutoMixer was developed in France by P. L. A. Thiberge and is reported to be standard equipment at most of the refineries operating in that country. The machine has been installed in several American refineries for demonstration purposes, and test machine is being operated in the plant of The Atlantic Refining Company at Philadelphia.

Maurice Partiot, 230 Park Avenue, New York, is the American representative for the French company, and controls the American rights.

Transmission

LINK BELT COMPANY

Link Belt Company, 910 South Michigan Avenue, Chicago, has announced a self-adjusting, positive variable speed transmission for fractional horsepower duty. It will be called the V. R. D. model (Variable Roller Drive).

The transmission is capable of an output of one half horsepower at maximum speed, with a maximum ratio of speed variation of 10 to one. It is of all-metal construction, fully enclosed, self lubricated, and uses a chain for positive transmission of power. This novel chain has a wide contact, and consists of steel links made endless and connected by hardened steel pins in hardened steel joint bushings.

Hose Mask

E. D. BULLARD COMPANY

E. D. Bullard Company, 275 Eighth Street, San Francisco, announces a new blower for hose masks and reel hose mask. The blower is made with an aluminum case and designed with larger blades and it is claimed that it will deliver increased quantity of air up to 27.5 percent. The reel hose mask outfit consists of a face piece and safety belt, a metal reel on which is wound 50 feet of non-kinking hose, and the leight weight aluminum blower—all packed in a strong fiber trunk. Air may be fed directly from the blower in the trunk if desired, or in the event a more convenient place for the blower is near the wearer of the mask, the blower is simply lifted out of the trunk with the reel of hose and carried to the most convenient location. Both the blower and the reel of hose are mounted on separate oak bases. The apparatus is approved by the U. S. Bureau of Mines, according to the manufacturer.

Alloys

HAYNES STELLITE COMPANY

Haynes Stellite Company, Kokomo, Indiana, has announced three alloys known as Hastelloys A, C and D. Hastelloy A can be supplied in the form of castings, rolled bars, plates or sheets; rolled, forged and cast rounds, welded tubing and wire. Hastalloys C and D can be supplied as castings only. Hastalloy A is a Nickel-Molybdenum-Iron alloy of high strength and good ductility developed for its resistance to acids. Hastalloy C is a Nickel-Molybdenum-Chromium-Iron alloy, and is also highly resistant to acids. Hastelloy D is a cast alloy of Nickel-Silicon-Copper and Aluminum, and resistant to corrosive agents. These alloys are applicable to a number of usages, and in the refining industry are found in such items as condensers, fractionating columns, kettles, mixer parts, cast pipe, pipe fittings, pump parts, centrifugal pumps, sleeves, sludge burner castings, spray nozzle shells and vanes, welded tubing, valves, valve parts, and reaction vessels.

Chrome Cement

BOTFIELD REFRACTORIES CO.

Botfield Refractories Company, Swanson and Clymer Streets, Philadelphia, announce addition of "Adachrome" super-cement to its line of Adaproducts. Adachrome is an improved chrome base refractory which is shipped in prepared, ready to use form in 250- and 500-pound metal drums with air-tight, replaceable full-opening covers.

The base of this improved cement is

Adacrome Package

high grade South African chrome ore with a high chronic oxide content and very low silica content. The grain sizes are prepared and graded accurately before material is mixed.

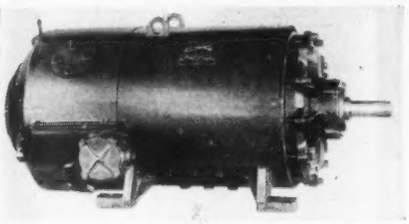
The cement is said to be smooth and plastic, free from shortness, and workable even on refractory insulating brick which quickly absorb moisture from bonding mortars, economical in amount required, and to be speedy in application.

Adachrome super-cement is stated to develop a strong air set in a short time after application, without requiring heat. It does not contain silicate of soda. Its bond is attained by virtue of practically zero shrinkage, a crystalline structure and a non silicate binder. The bond of the material is non-fluxing and non-glazing, even in the higher ranges of temperature.

Motor

THE LOUIS ALLIS COMPANY

The Louis Allis Company, Milwaukee, Wisconsin, announces the addition of direct current, fan-cooled, explosion-proof motors to its line of explosion-proof motors. Quick and easy



Louis Allis Motor

inspection of the commutator and brushes is made possible by three quickly removable screw caps. The motor shown in the illustration is a 25-horsepower explosion proof motor at 806 R.P.M.

Variable Drive

ROOTS-CONNERSVILLE BLOWER CORPORATION

Roots-Connersville Blower Corporation, Connersville, Indiana, is supplying its blowers, vacuum pumps, and gas pumps connected through a variable speed drive to a constant speed motor. It is pointed out by the manufacturers that, where variations in the volume are required, a unit of this type offers advantages in the process industries.

In the rotary positive type of machine, the power consumption varies in almost direct proportion to the volume and the pressure being delivered; thus the use of a variable speed arrangement permits this economy to be carried through the entire operating range. Savings of this kind, coupled with the convenience afforded by flexibility as to volume and pressure, account for the adoption of this type of drive.

Roots-Connersville equipment arranged in this way is suitable for those industries where seasonal peaks or processing technique makes changes in the volume advantageous or necessary. Applications of this sort are to be found in chemical plants, paper mills, ice plants, gas works, oil refineries, sugar mills, and many other processing plants.

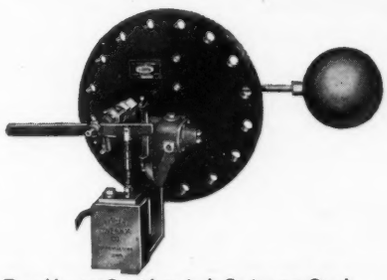
Variable speed drives have also been used in connection with cycloidal rotary pumps, which are built for heavy duty service, including the handling of viscous liquids, or for producing vacuums up to 26-inch Hg, for handling vapor and liquid together.

Arc Welder Control

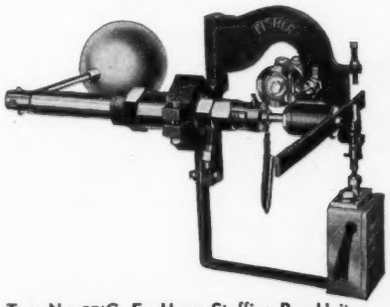
LINCOLN ELECTRIC COMPANY

Lincoln Electric Company, Cleveland, Ohio, announces a new remote control device for arc welding machines. It requires no additional cables or other apparatus. The operator taps the electrode on the work several times to automatically raise the voltage; a larger number of taps causes the voltage to be lowered. Thus by merely tapping the electrode — making and breaking the electrical circuit—the current output of the generator is con-

STAY INSIDE with these FISHER CONTROLLERS



Type No. 233C, with 10 inch Series 40 Steel Flange. Ball Bearing Stuffing Box Pilot Valve and Oil Seal Switch.



Type No. 271C, Ex. Heavy Stuffing Box Unit. Ball Bearing Rotary Stem (with vacuum seal) and with 3-light Oil Submerged Switch and Type No. 779 Pilot Valve.

It is no longer necessary to have an outside Float Cage to obtain good Liquid Level Controllers.

Fisher, having pioneered the Outside Float Cage type of control for many years, has also lead the way on inside Float Controls. There are three series of inside Float Level Controllers. Two of these, the Type No. 233C and Type No. 271C, are illustrated above.

Not babies or juniors--these Controllers are tough, sturdy "He-Man" units of full size construction. Heavy enough for any service and accurate enough for the most critical control.

This equipment is available with a number of variations: bolted flange type or with extra heavy screwed stuffing box type to mount directly on the tower wall. Can be furnished with pilot valve for remote operation of Diaphragm Motor Valve or with the special safety oil submerged three-light indicating mercury switch or both. Suitable for all pressures and operating conditions.

Outstanding refinery construction and designing engineers are using these controls in greater numbers on every job. These are proved controls that have been used successfully for several years on such installations as separator water drawoff, reflux drum, residuum vacuum tower on asphalt, or heavy oils, and innumerable other refinery and gasoline plant level control points.

Fisher engineers will gladly give you the benefit of their experience in solving any control problem you may have. If you have no immediate problems, at least modernize your ideas.
Write today for the new FISHER Catalogue.

Fisher Governor Company

1015 SANTA FE AVENUE, LOS ANGELES, CALIF. — FISHER TRADE MARK — 50 CHURCH STREET, NEW YORK, N. Y.
201 SOUTH FIRST AVENUE, MARSHALLTOWN, IOWA

A Shot Gun Won't Stop an Elephant

...Neither will the Wrong Extinguisher Stop an Oil Fire

HERE IS AN EXTINGUISHER THAT PUTS OUT THREE DIFFERENT KINDS OF OIL FIRES—NOT JUST ONE

BRIEFLY here are the facts; LUX extinguishers put out oil or gasoline fires burning on the ground as quickly as any other hand extinguisher. They put out fires in gasoline streaming through the air from a leaking pipe or overflowing tank truck against which other extinguishers fail. They also put out fires in live electrical equipment safely. No other type of extinguisher is effective against all of these fires.

You can't predict what your next fire will be. You know that the wrong extinguisher will be useless. Why not investigate LUX which will give you protection against all three?

Write for the free folder, "White Magic." Walter Kidde & Company, Inc., West Street, Bloomfield, N. J.

LUX

Triple Fire Protection for Refineries—Bulk Plants—Trucks

Lincoln Welder

trolled. The operator can work at any distance from the machine and regulate the current accurately without making trips back and forth to adjust the controls. This effects a saving in time for welder and machine. The mechanism is encased in a small box which may be quickly attached to the welder voltage control. Regular hand controls may still be used as desired. The device is offered as optional equipment with the new Lincoln Shield-Arc Welders, or it may be purchased separately and installed on motor-driven, belt-driven, or gasoline engine-driven welders now in use.

Manometer

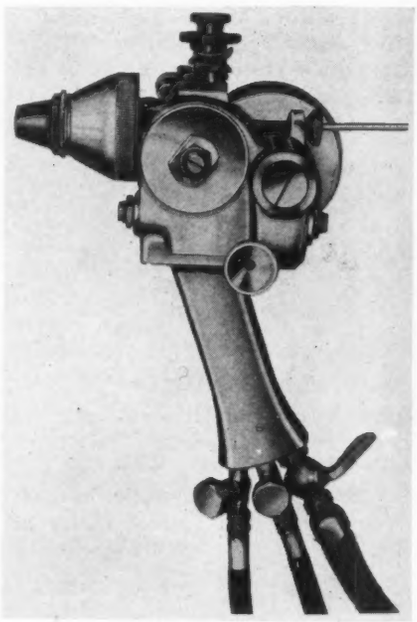
THE MARIAM COMPANY

The Mariam Company, 1955 West 112th Street, Cleveland, announces a new type of manometer fitter with automatic electric control features. The new instrument is stated to be unusually rugged and simple, and to remain permanently accurate under the severest service conditions. It is adaptable to a wide variety of direct and differential control uses for pumps, liquid levels in tanks and sprinkler systems, and for maintaining gas pressure and flow between close limits; or for starting and stopping the flow in two pipes alternately for special purposes. Other uses suggested are the automatic starting of a reserve pump in case of a failure of the regular unit to operate, the production of alternate pressure and vacuum in a closed vessel, or for electrically operated remote control of steam valves, etc. It has the additional advantage of providing a visible reading of performance at all times. Two separate glass tubes are used instead of the usual U-tube. These two tubes are gasketed at their lower ends into an iron block which is drilled so as to provide the U-connection between them. Three terminals are provided—one on the block and the other two at the respective upper ends of the tubes. These latter terminals are connected to non-corroding adjustable tungsten wires which pass through the bakelite plugs in the upper ends of the tubes and which may be set so that either of them contact with the mercury at the predetermined differential pressure or vacuum.

Metal Spray Gun

METAL SPRAY COMPANY

Metal Spray Company, 113 Llewellyn Street, Los Angeles, has developed a new type of metal spray gun for spraying all metals in molten form to resist corrosion, replace wear, and other applications. The new gun is said to be lighter in weight, easier to operate, to require less maintenance and is perfectly balanced. The power plant is completely separated from the combustion unit. The nozzle is said to permit quick and correct adjustment



Metal Spray Gun

of the flame and to reduce backfire. The gun is provided with individual valve controls for acetylene, oxygen and air. The knurled wire feeding wheels are located outside of the gear case to obtain visible control, prevent fouling and excessive wear from the metal particles and scale on the wire. Full manual control of the vertical coiled spring is provided, to exert any pressure desired on the wire feeding wheels, preventing slippage of wire and permitting accommodation for the large variety of hard and soft metals. The gear case is completely enclosed and packed with lubricant. The turbine air control valve and all other controls are on one side of the gun so they may easily be operated with one hand. The gear case casting is sand cast nickel-aluminum alloy. All bearing

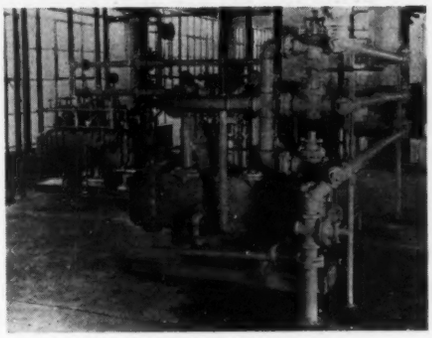
retainer caps, turbine housing and air cap base are of duraluminum. The wire guides, wire feeding wheels, and steel wire feeding control parts are of specially hardened steel. The shafts are ¼-inch diameter and gears extra heavy. Bearings are of bronze and ball type. The worms are made from a .20 carbon chrome-manganese steel, casehardened with threads polished. The gears are made from naval bronze. Model 126 sprays all metals ⅛-inch diameter wire. Model 81 sprays all metals in 12 gauge Brown & Sharpe size wire. All metals to be sprayed may be used in coils or reels.

Boiler

THOMPSON BOILER WORKS

Thompson Boiler Works, Los Angeles, California, has announced a new type boiler which operates without tubes, flues or coils. Instead of heating the water in the usual manner, this boiler heats one end of iron segments. The heat is transferred to ends of segments submerged, and starts the water to boiling on the inside.

These tubeless boilers are manufactured in a range of sizes from three to 30,000 horsepower. The vertical type range from three to 150 horsepower, the horizontal from three to 250 horsepower, and the water tubeless type from 150 to 30,000 horsepower. The 250 horsepower horizontal type boiler uses 11,400 heat transfer segments.



Homestead Valves

Valves

HOMESTEAD VALVE MFG. CO.

Homestead Valve Manufacturing Company, Coraopolis, Pennsylvania, has announced improved models in its line of valves for use in such industries as petroleum refining, chemical trades, paper pulp, textiles, foods, steel and others in which service requires the use of a wide variety of metals for securing best results in resistance to corrosion. Special charts have been prepared which are designed to show proper types of valves for various requirements. Metals used include steel, Monel metal, bronze, brass, nickel, stainless steel, semi-steel, as conditions require. The valves are designed so that the valve seats are protected from grit, dirt, sand, and other corrosive or abrasive materials. The lock and cam arrangement for seating plug valve is said to press the plug firmly and automatically into the seat when the valve is in the closed position.

Respirators

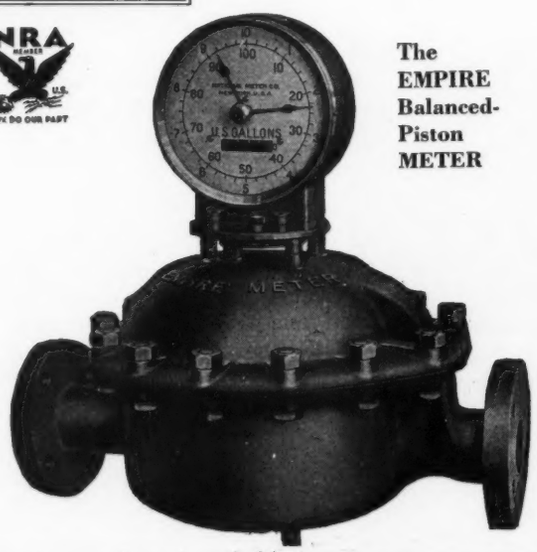
PULMOSAN SAFETY EQUIPMENT CORPORATION

Pulmosan Safety Equipment Corporation, 176 Johnson Street, Brooklyn, New York, announces a new line of improved respirators for protecting workers against inhaling lead, silica, and similar dusts, and spray mists. The new line is called the "M" series and and among the improved features reported by the manufacturer are the following:

An increased filter size, a direct breathing intake and coarser mesh wire screens, to permit easier breathing. Screens are bound with aluminum for greater strength and safety. A gas

EMPIRE
FOR ALL LIQUID PETROLEUM PRODUCTS
OIL METERS
NATIONAL METER COMPANY

NRA MEMBER U.S. WE DO OUR PART



The EMPIRE Balanced-Piston METER

Made in LARGE as well as small sizes—from ⅝-inch to 6-inch. Standard types for 150 lbs. per sq. in. working pressure. High pressure types to 325 lbs. and up. Registers as illustrated, or other types, as required.

NATIONAL METER COMPANY
4213 First Avenue, Brooklyn, N. Y.
BOSTON CHICAGO SAN FRANCISCO LOS ANGELES

GOOD USED BOILERS

Completely Equipped, Installed

Guaranteed and Insured
Terms can be arranged

Boiler Settings Masonry Chimneys
Still Settings Foundations

Furnace Construction Co.
1216 Tower Petroleum Bldg., Dallas, Texas.

Take Advantage of K & M Full Range

You can place a full range equipment order with **one** responsible manufacturer when you specify K & M apparatus. Result: full range service, full range performance and full range responsibility.

Whether it is a valve, a liquid level controller, pump governor or steam trap, there is a K & M product, time tried and of proved performance to fill your need.

K & M's 55 years of conscientious service in the engineering specialty field have given to the entire K & M Line a dependability which has developed many enthusiastic FULL Range users of K & M products.

Check the items below for which you may have need in the future and let us send you full information concerning them.

KIELEY & MUELLER, Inc.

Main Office and Warehouse:

34 W. 13th St., New York, N. Y.

Plant: **Newark, N. J.**

K and M

PRESSURE AND LEVEL CONTROL APPARATUS

- ☐ **Pressure Regulating Valves**
- ☐ **Air Pilot Operated Valves**
- ☐ **Balanced Valves**
- ☐ **Back Pressure Valves**
- ☐ **Pump Governors**
- ☐ **Steam Traps**
- ☐ **Liquid Level Controllers**
  - **Direct Connected**
  - **Remote Control**
  - **Internal or External Float**

Name .....

Firm .....

Address .....

City ..... State .....

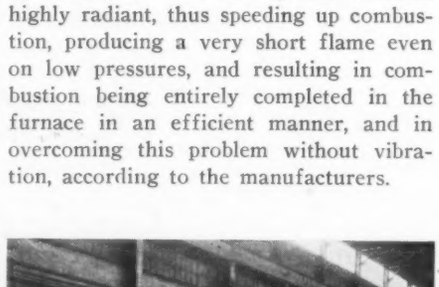
mask type exhaust valve is used, that is positive in action. A change from elastic headbands to all-rubber, adjustable headbands for longer wear. Headbands are attached to a swivel joint that allows free movement of the head without respirator leaving the face. New construction prevents obstruction of wearers' vision. Goggles can be worn without interference. Knitted fabric covers the rubber face cushion to add comfort. Only tested filters are used.

Gas Burner

BOILER SPECIALTY COMPANY

Boiler Specialty Company, Houston, announced a new line of gas burners under the trade name "Red Devil," which are designed for firing all types of steam boilers, kilns and furnaces, and for conditions where varying loads and automatic regulation are contemplated.

Through the use of a large number of small spuds or jets the total gas is subdivided into a multiplicity of small streams issuing from these spuds at a high velocity. The gas is then allowed to expand into the refractory Venturi throats whereby air for combustion is inspirated into and through the throat, causing a thorough mixing of incoming air with gas. The mixing tubes become highly radiant, thus speeding up combustion, producing a very short flame even on low pressures, and resulting in combustion being entirely completed in the furnace in an efficient manner, and in overcoming this problem without vibration, according to the manufacturers.



Struthers-Wells Company recently completed construction and shipment of a large fractionating column 10 feet in diameter and 58 feet high. The column and accessories was completely arc welded, using Fleetweld electrodes manufactured by The Lincoln Electric Company, Cleveland. Shell thickness of the tower is ¾-inch while the heads are of ⅞-inch. On completion of the welding the entire unit was heat treated. The column was shipped to Canada for refinery service in connection with the Dubbs cracking process.

Economy! **"3-in-1" PULMOSAN Respirator**

PATENTED

Buy one respirator and several parts. Interchanging parts gives protection for dusts, fumes, smoke, paint spray mists.

Write for details

PULMOSAN SAFETY EQUIPMENT CORP.
176 Johnson St. Brooklyn, N. Y.

A.S.T.M.-C.F.R. OCTANE RATINGS
Natural Gasoline and Gas Analysis
Using Podbielniak apparatus.
All other tests on Petroleum Products.
Phoenix Chemical Laboratory
"an exclusive petroleum testing laboratory"
3953 Castello Ave. Chicago, Ill.

Electrically Driven Centrifuges
Hand Centrifuges
WRITE
WILLIAMS, BROWN & EARLE, Inc.
Manufacturers of Laboratory Apparatus
918 Chestnut St. Philadelphia, Pa.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912,

Of The Refiner and Natural Gasoline Manufacturer, published monthly at Houston, Texas, for April 1, 1934.

State of Texas, County of Harris: ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared A. L. Burns, who, having been duly sworn according to law, deposes and says that he is the Business Manager of The Refiner and Natural Gasoline Manufacturer and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher: R. L. Dudley, 3238 Huntington Drive, Houston, Texas.

Editorial Director: S. W. Robinson, 5002 Scotland, Houston, Texas.

Editor: George Reid, 1651 Danville, Houston, Texas.

Managing Editor: J. Kent Ridley, 605 Sul Ross, Houston, Texas.

Business Manager: A. L. Burns, 4311 San Jacinto, Houston, Texas.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)

The Gulf Publishing Company, Houston, Texas; James Anderson, Houston, Texas; R. L. Blaffer, Houston, Texas; Mrs. Sarah Campbell Blaffer, Houston, Texas; A. L. Burns, Houston, Texas; J. F. Carter, Jr., Tulsa, Okla.; Dr. N. L. Dudley, Goose Creek, Texas; R. L. Dudley, Houston, Texas; W. S. Farish, Houston, Texas; Wm. V. Gross, Houston, Texas; Howard R. Hughes, Houston, Texas; Chas. H. Lane, Houston, Texas; Wallace E. Pratt, Houston, Texas; J. Kent Ridley, Houston, Texas; S. W. Robinson, Houston, Texas; Mrs. Maude G. Sterling, Houston, Texas; R. P. Swinsky, New York, N. Y.; O. R. Waller, Chicago, Ill.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

A. L. BURNS,
Business Manager.

Sworn to and subscribed before me this 3rd day of April, 1934.

(Seal) J. KENT RIDLEY.

(My commission expires June 30, 1935.)

Items About Manufacturers

Republic Steel Corporation, Youngstown, Ohio, N. J. Clarke, vice president in charge of sales, announces appointment of Gate City Iron Works Company, Omaha, Nebraska, and Earle M. Jorgensen Company, Los Angeles, California, as distributors of Enduro Stainless Steel, making a total of 41 distributor warehouse stocks in principle cities. The steels are produced by Republic's Central Alloy Division, Massillon, Ohio.

Ingersoll-Rand Company, 11 Broadway, New York, announces that Batt L. Spain, who has been for the past 24 years with the General Electric Company at the West Lynn works as manager of turbo-blower sales, now is with the company as manager of the turbo-blower department. The occasion for the transfer of Mr. Spain is the acquisition of the turbo-blower business of General Electric Company by Ingersoll-Rand Company.

Republic Steel Corporation, Youngstown, Ohio, announces appointment of Gate City Iron Works, Omaha, Nebraska, as distributors of Toncan Copper Molybdenum Iron.

H. O. Swoboda, Inc., Pittsburgh, has appointed Maxfield Pease, 4614 Prospect Avenue, Cleveland, as sales representative in northern Ohio.

Dow Chemical Company has moved its New York offices to 30 Rockefeller Plaza.

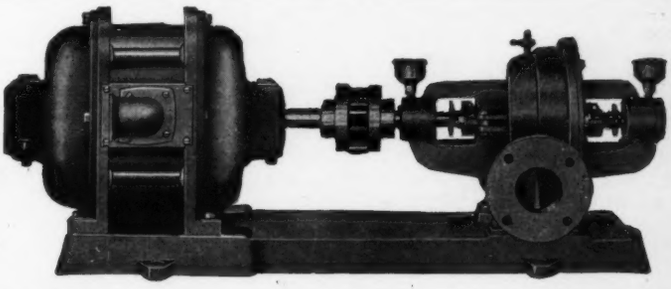
Thiokol Corporation, Yardville, New Jersey, announces exclusive license contracts signed with leading wire and cable manufacturers in five European countries, the appointments being made through its subsidiary, Thiokol, Ltd., and are as follows: British Insulation Cables Ltd., Prescott, Lancaster, England; Felton & Guilleaume Carlswerk, Cologne, Germany; Forges et Ateliers de Constructions Electriques de Jeumont, (Nord) France; Societa' Italiana Pirelli, Milan, Italy, and Comercial Pirelli, S. A., Barcelona, Spain. These companies will manufacture cables of several types embodying Thiokol both as a protective sheath and as an insulator.

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., announced election of two new directors, as follows, A. L. Humphrey, chairman of the board of Westinghouse Air Brake Company, and H. S. Wherett, president of Pittsburgh Plate Glass Company. Directors re-elected for the term expiring in April, 1938 were Jerome J. Hanauer, financier, of New York; W. L. Mellon, chairman of the board, Gulf Oil Corporation, Pittsburgh; F. A. Merrick, president of Westinghouse Electric & Manufacturing Company, Pittsburgh; and Geo. M. Verity, chairman of the board, the American Rolling Mill Company, Middletown, Ohio; and for the term expiring April, 1935, Winthrop W. Aldrich, chairman of the board, Chase National Bank, New York.

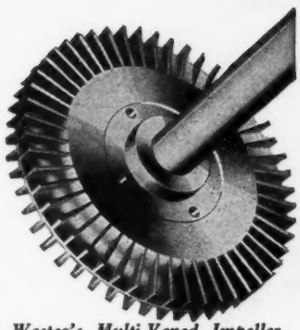
Bowen Air Lines has announced a new passenger schedule that brings Gulf, Mid-Continent and Eastern cities to within a few hours of each other. The time between several cities follows:

Dallas to Kansas City, 3½ hours; Dallas to Chicago, 6¼ hours; Dallas to St. Louis, 4½ hours; Dallas to New York, 13½ hours; Dallas to Oklahoma

THIS PUMP does NOT vapor bind!



For handling volatile liquids containing large amounts of vapor, select Westco Turbine Pumps every time.



Westco's Multi-Vaned Impeller. It does the "business".

NUMEROUS large Refiners and Natural Gasoline Plants swear by Westcos on account of their high efficiency when handling light, volatile gasoline, propane, etc., with 100° to 130° A. P. I. gravity. On such severe duties, this advanced, turbine-type pump operates against pressures up to 300 lbs. per square inch without becoming vapor bound.

High Pressures in Single-Stage

Westco's re-energizing pump action produces pressures which, in many cases, are as much as *20 times greater* than those produced by conventional type centrifugals with the same diameter Impeller.

Automatically Adjust

Even if the operating pressure might fluctuate considerably, Westco *automatically adjusts itself* to such changes. A steady, non-pulsating flow is assured at all times. By increasing the efficiency of the towers, this characteristic makes Westco the ideal pump for feed and reflux duty on high pressure stabilizers. Our Refiner friends also like Westcos for Still Charging and for handling Hot Oil, Fuller's Earth, Chlorine Treating Solutions, Mineral Seal Oils, Naphtha, Brine, Water, etc.

Send Coupon for Details

Just fill in the coupon below and mail it today for FREE Catalog together with Performance and Selection Tables. WESTCO PUMP CORPORATION, Davenport, Iowa. *Branches:* New York, Philadelphia, Chicago, Los Angeles and San Francisco. *Representatives in 50 Principal Cities.*

COUPON BRINGS DETAILS

WESTCO PUMP CORPORATION,
Davenport, Iowa. Dept. N-5

Gentlemen: Without obligation, please send me your Catalog and Performance and Selection Tables for Westco Turbine Pumps.

Name .....

Address .....

City .....

State .....

WESTCO *TURBINE* PUMPS

HIGH PRESSURE - - - SINGLE STAGE

Beware of these Enemies!

The Protectomotor Air Filter is *guaranteed* to eliminate 99-9/10% of the dust and dirt from air delivered to machines. Consequently it

—Reduces 75 to 85% of the wear on cylinders, pistons, bearings and valves.

—Cuts down carbon deposits 60 to 70%.

—Enables machines to operate from 3 to 5 times longer without overhauling and makes them more efficient.

—Eliminates loss of costly compressed air wasted when valves stick.

—Reduces oil consumption materially, and silences the noise.

Write for Catalog and information about our 30 day FREE trial offer.

Staynew Filter Corp.
21 Leighton Ave. Rochester, N. Y.

PROTECTOMOTOR
REG. U.S. PAT. OFF.
99 9/10 Per Cent EFFICIENT
AIR FILTERS

Make Comparative Tests

We suggest that you do what many others have done:—make side-by-side comparative tests on your own refinery boilers of CAMPBELL vs. any other feed water regulator. You will then do the same thing they did—you will install

CAMPBELL
Boiler Feed Regulators on ALL Boilers

The CAMPBELL is unquestionably the simplest, most rugged, and most dependable of all regulators owing to the fact that it has (1) No thermostats; (2) No generators; (3) No floats; and (4) No moving parts in the regulating element. It is the IDEAL regulator for refinery service.

Patented

ATLAS VALVE COMPANY
REGULATING VALVES FOR EVERY SERVICE
275 South St., Newark, N. J.

Clip this coupon to your letterhead, check the items in which you are interested, mail, and we will gladly send prices and data. No obligation.

- ☐ The Campbell Boiler Feed Water Regulator
- ☐ Reducing Valves
- ☐ Damper Regulators
- ☐ Exhaust Control System
- ☐ Temperature Regulators
- ☐ Pump Governors
- ☐ Float Valves
- ☐ Swing Joint Fittings
- ☐ Bronze Unions
- ☐ Thermostats
- ☐ Balanced Valves
- ☐ Control Valves

City, 1-1/3 hours; Dallas to Houston, 1¾ hours; Dallas to Tulsa, 1¾ hours; Dallas to San Antonio, 2½ hours; Dallas to Austin, two hours; Houston to Kansas City, 5½ hours; Austin to Kansas City, 5½ hours; San Antonio to Kansas City, six hours; Dallas to Indianapolis, 6¾ hours; Dallas to Columbus, 8½ hours; Dallas to Pittsburgh, 10 hours; Dallas to Philadelphia, 12¾ hours; San Antonio to New York, 19 hours; Houston to New York, 18½ hours; Austin to New York, 18½ hours.

Alfred J. Jupp, vice president of Lunkenheimer Company, Cincinnati, died suddenly in Roosevelt Hospital, New York, April 10, 1934, which on a business trip.

Born in Cincinnati, June 25, 1875, Mr. Jupp entered the employ of Lunkenheimer Company in May, 1890. In 1896 he was made New York representative, returning to the home office in Cincinnati in 1913.

Mr. Jupp was active in the Manufacturers' Standardization Society and also contributed the greater part of his time during recent months to code work in the Valve and Fittings Industry.

Mr. Jupp was a member of the A. S. M. E., A. S. T. M., S. N. A. M. E. and in Cincinnati he belonged to the Engineers, Cincinnati, Queen City and Cuvier Press Clubs. He was unmarried and made his home with his sister.

Interment was in Southbridge, Massachusetts, April 13.

American Meter Company has announced removal of its New York office from 105 West 40th Street to Room 2925 Lincoln Building, 60 East 42nd Street.

Wackman Welded Ware Company, Seventh and Victor Streets, St. Louis, Mo., has established warehousing and delivery facilities at 516 South Franklin Street, Chicago, to serve the Chicago district with steel barrel requirements. V. A. Holmes has been appointed district representative in charge of Chicago sales.

The Duriron Company, Dayton, Ohio, has transferred G. A. Baker, formerly manager of its Buffalo Office, to the general office at Dayton. Col. M. W. Smith is temporarily in charge of the Buffalo office.

Allis Chalmers Manufacturing Company, Milwaukee, Wis., has appointed B. F. Bisland manager of its Chicago office, and A. J. Cooper assistant manager of the New York office.

American Cyanamid Company and subsidiaries, including the Chemical Construction Corporation, has moved New York offices on April 15 to 30 Rockefeller Plaza.

Solvay Sales Corporation, on May 1 moved its offices in Philadelphia to 12 South 12th Street.

Homestead Valve Manufacturing Company, Coraopolis, Pennsylvania, announces the following new exclusive representatives for Homestead valves: Grinnell Company, 240 North Highland Avenue, Atlanta, Georgia; L. E. Livingston, 2012 Ward Parkway, Fort Worth, Texas, and National Supply Company, Toledo, Ohio.

The company announces for the first time the following Hypressure Jenny Vapor Spray Cleaning Machine representatives:

For the Indianapolis district, South Side Body Company, Inc., 109 West Morris Street, Indianapolis; for northern Texas, L. E. Livingston, 2012 Ward Parkway, Fort Worth; for Minnesota, North and South Dakota, William H. Ziegler Company, 2331 University Avenue, S. E. Minneapolis; for Philadelphia area, Brogan and Company, 810 Race Street, Philadelphia; for Pittsburgh and tri-state area, Beckwith Machinery Company, 6550 Hamilton Avenue, Pittsburgh; for southeastern Texas, James A. Hall, 110 Byrne Street, Houston; and for the state of Wisconsin, Boehck Equipment Company, 2404 West Claybourn Street, Milwaukee.

George P. Reintjes Company of Kansas City, manufacturers of refractory arches, furnace equipment, etc., for the petroleum and other industrial lines, will have a special exhibit at the Stevens Asbestos Products Company, 216 East 7th Street, in Tulsa in connection with the International Petroleum Exposition there.

Coppus Engineering Corporation, Worcester, Mass., announces appointment of Lawrence K. Cecil, 1531 East 35th Street, Tulsa, to handle sales of Annis air filters for air compressors and for industrial and ventilating applications in the Oklahoma and Texas territory.

Harry W. McQuaid, Republic Steel Corporation, Youngstown, Ohio, delivered an address on "Grain Size in Carburizing and Forging Steels" before a dinner given by the Cincinnati, Dayton and Columbus Chapters of the American Chemical Society, Tuesday, April 24, at the Athletic Club, Columbus.

▼ CATALOGS . . . BULLETINS ▼

Helpful Publications Which Manufacturers Will Be Glad to Send Free for the Asking

Chemical Price List

The quarterly price list of "R. & H. Chemicals for All Industries" has just been issued by the R. & H. Chemicals Department of E. I. du Pont de Nemours & Company, Wilmington, Deleware.

This informative booklet not only quotes current prices of the products, but also contains pages of descriptions of such leaders as Artic, a refrigerant; non-flammable solvents; Duozinc for planting purposes; feldspars; peroxides; P. A. C. formaldehyde, and ceramic colors and other ceramic materials. The various chemicals discussed include those required in the chemical, metal, textile, rubber, leather, oil, ceramic and some other industries. In all, nearly 200 different chemical products receive mention or more or less detailed description.

Welding Fittings

Taylor Forge & Pipe Works, Chicago, Ill., has published a 64-page illustrated catalog covering Taylor Forge Welding Fittings and Flanges, including detail information and charts on flexibility of welded piping design, and general engineering data pertinent to use of welding fittings.

Scales

The Kron Company, Bridgeport, Conn., is distributing a new condensed catalog, No. 7, describing its line of industrial dial scales, including illustrations, drawings, and detail information on all types of scales made by this company.

Compressors

Gardner-Denver Company, Quincy, Illinois, has issued a new bulletin, HAC 36, illustrating and describing its duplex two-stage horizontal compressors.

Brick

General Refractories Company, 106 South 16th Street, Philadelphia, has issued a new bulletin describing that company's carbex silicon carbide brick.

Capacitors

General Electric Company, Schenectady, N. Y., has issued bulletin GEA-77F, in which G-E capacitors, pyranol treated, are discussed. It is a 28-page booklet with the title "Improving Power Factor for Profit."

Welding Rod

American Manganese Steel Company is distributing Bulletin No. 1, Nickel-Manganese Steel Welding Rod, Bulletin 2, on No. 459 hard-surfacing welding rod, and has ready for distribution revised price schedules.

Plug Valves

The Lukenhiemer Company, Cincinnati, Ohio, has issued a new bulletin describing the company's "Ferrenewo" and "Renewo", plug type valves. The booklet is well illustrated and gives specifications for all types of valves and parts.

Thermometers

The Brown Instrument Company, Philadelphia, Pa., has published a new 32-page illustrated catalog featuring the Brown resistance thermometer for measuring temperatures from —300°F. to 1,000°F. The instruments are available in indicating, recording and controlling types and include several improved features.

Coolers

Frick Company, Waynesboro, Pa., has issued Bulletin No. 153-C "Ice and Frost," dealing with instant water coolers for business and industrial establishments. The company has also issued Bulletin No. 189-A, a revised price list of ammonia valves and fittings, and carbon dioxide valves and fittings.

Heating Devices

General Electric Company, Schenectady, N. Y., is distributing Bulletin GEA-1520B, on G-E electric heating units and devices, illustrated, including engineering data on immersion heaters, cartridge units, strip heaters, calrod units, cast-in hotplates, control equipment, thermostates and other similar equipment.

Motors

Fairbanks-Morse & Company, Chicago, is distributing a four-page folder giving information on F-M splashproof motors built to withstand rigorous service such as frequent washing down of machines excessive moisture and steam, falling particles of any kind of alkalies, etc.

Grinding

Raymond Bros. Impact Pulverizer Company, in the Raymond Review, 1933, a 16-page booklet, illustrates some of the more important and unusual operations performed by the company's equipment in the manufacture of powered materials, including units for pulverizing and air-separating, drying, powdered coal and coke firing, disintegrating and dehydrating products of high moisture content, extreme fine grinding, cooling and pulverizing, etc.

Compressors

Worthington Pump & Machinery Corporation, Harrison, N. J., is distributing a new illustrated bulletin on Worthing refrigeration compressors, horizontal single type, belt-driven, direct-connected to motor, steam-driven.

Directory

Pittsburgh Plate Glass Company, Pittsburgh, presents in "Index and Directory for 1934", lists of the concerns subsidiaries, divisional offices, manufacturing divisions, and products, which include many items used in the refining industry.

Potentiometer

C. J. Tagliabue Manufacturing Company, Park and Nostrand Avenues, Brooklyn, N. Y., is distributing an illustrated bulletin on the new Tag Photoelectrically balanced recording potentiometer.

Nuts

The Columbia Nut & Bolt Company, Inc., Bridgeport, Conn., is distributing a new bulletin describing the Columbia "Gib" nut lock and Columbia lock nuts.

Alloys

Haynes Stellite Company, Kokomo, Indiana, is distributing an illustrated pamphlet and a bulletin dealing with its new acid resistant alloys, Hastelloys, A. C. and D. The two pieces of literature completely describe the alloys, their purposes of development and their many applications.

Equipment

Worthington Pump and Machinery Corporation, Harrison, N. J., is distributing an interesting, illustrated booklet, dealing with Worthington equipment for the refinery and natural gasoline plant, describing and picturing centrifugal, rotary, duplex, pumps, hot oil pumps, engines, compressors condensing and vacuum equipment and portable air compressors.

Converters

Louis Allis Company, Milwaukee, Wisconsin, has published two bulletins on converters. Bulletin No. 509-A completely illustrates and describes construction, operation and uses of various types of frequency converters. Bulletin No. 502-B describes and illustrates inverted rotary converters.

Alloy Steel

American Manganese Steel Company, 6600 Ridge Avenue, St. Louis, Missouri, has issued a bulletin dealing with Amsco Alloy, a series of cast nickel-chromium alloys for resisting heat corrosion and acids, which is available in six different analyses.

Pyrometers

Russel Electric Company, 379 West Huron Street, Chicago, is distributing a bulletin dealing with the specifications, uses, and general engineering information on its complete line of "Hold-Heet" Pyrometers.

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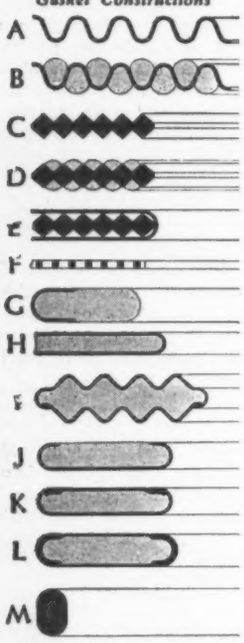

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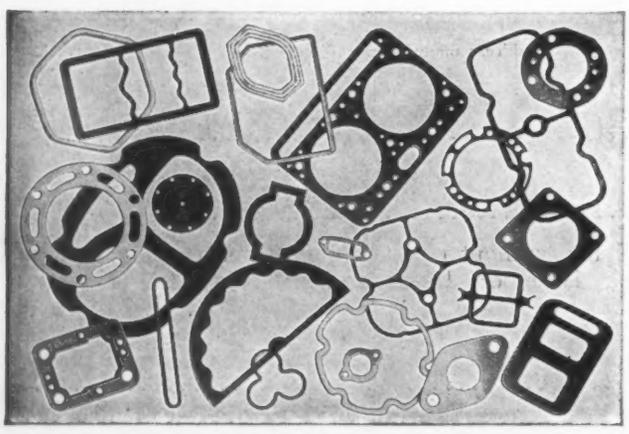

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Advertisers' Index

Airetool Manufacturing Company .....Third Cover
Alco Products, Inc. 23a
The American Brass Company.....7a
American Meter Company.....53a
Armstrong Machine Works 29a
Atlas Valve Company 78a

Bayway Engineering Company 55a
The Bristol Company 59a
The Brown Instrument Company.....24a

The Carbondale Machine Company 22a
The Chaplin-Fulton Manufacturing Company.....54a
Chemical Construction Corporation 21a
Chicago Bridge & Iron Works.....48a
Combustion Engineering Company 67a
Cooper-Bessemer Corporation .....Second Cover
Coppus Engineering Corporation 64a

DeLaval Steam Turbine Company.....35a
E. I. du Pont de Nemours & Company..... 8a
The Duriron Company 69a

The Eagle-Picher Lead Company 33a
Elliott Company 25a

Filtrol Company of California.....36a
Fisher Governor Company 73a
Fluor Corporation 15a
Foster Wheeler Corporation 17a
The Foxboro Company 10a
Furnace Construction Company 75a

The Garlock Packing Company.....34a
Gasoline Products Company 43a
General Cable Corporation 12a
General Electric Company 39a
Globe Steel Tubes Company.....11a
Goetze Gasket & Packing Company.....80a

The Haden Lime Company 42a

Ingersoll-Rand Company 40-41a
International Nickel Company 28a
Jerguson Gage & Valve Company.....36a
M. W. Kellogg Company.....20a
Walter Kidde & Company.....74a
Kieley & Mueller, Inc.....76a
Kinney Manufacturing Company 51a

The La Bour Company.....58a
Lagonda Manufacturing Company 44a
C. H. Leach Company.....34a
Leeds & Northrup Company 26a
Leonard Construction Company .....
Liberty Manufacturing Company .....
Lincoln Electric Company 61a
The Lummus Company 6a
The Lunkenheimer Company 18a

The Marley Company 71a
Mason-Neilan Regulator Company 5a
Mathews Conveyer Company 65a
The Mathieson Alkali Works 14a
Merco Nordstrom Valve Company.....30a
The Midvale Company 9a
Mine Safety Appliances Company.....32a
Multi-Metal Wire Cloth Company.....31a

National Meter Company 75a
National Tube Company 56a
North American Car Corporation.....50a

Oil Conservation Engineering Company.....52a

Petroleum Conversion Corporation 46a-47a
Phoenix Chemical Laboratory 75a
Pittsburgh Steel Company 37a
Pulmosan Safety Equipment Company.....76a

Reading-Pratt & Cady Company 27a
Republic Steel Corporation .....Fourth Cover
Ridge Tool Company 32a
The Roto Company 54a

Sarco Company .....
Solvay Sales Corporation 62a
Staynew Filter Corporation 78a
Sun Ship Building & Dry Dock Company.....4a

Taylor Instrument Companies 16a
Turbo Mixer Corporation 63a

Universal Oil Products Company 49a

Henry Vogt Machine Company.....38a

Wallace, Muller & Company 45a
Webster Engineering Company .....Front Cover
Westco Pump Corporation 77a
Westinghouse Electric & Manufacturing Co.....19a
Williams, Brown & Earle, Inc.....76a
J. H. Williams & Co.....72a
Worthington Pump & Machinery Corporation.....13a

York Ice Machinery Corporation.....70a